JULY 1960

# Power Engineering

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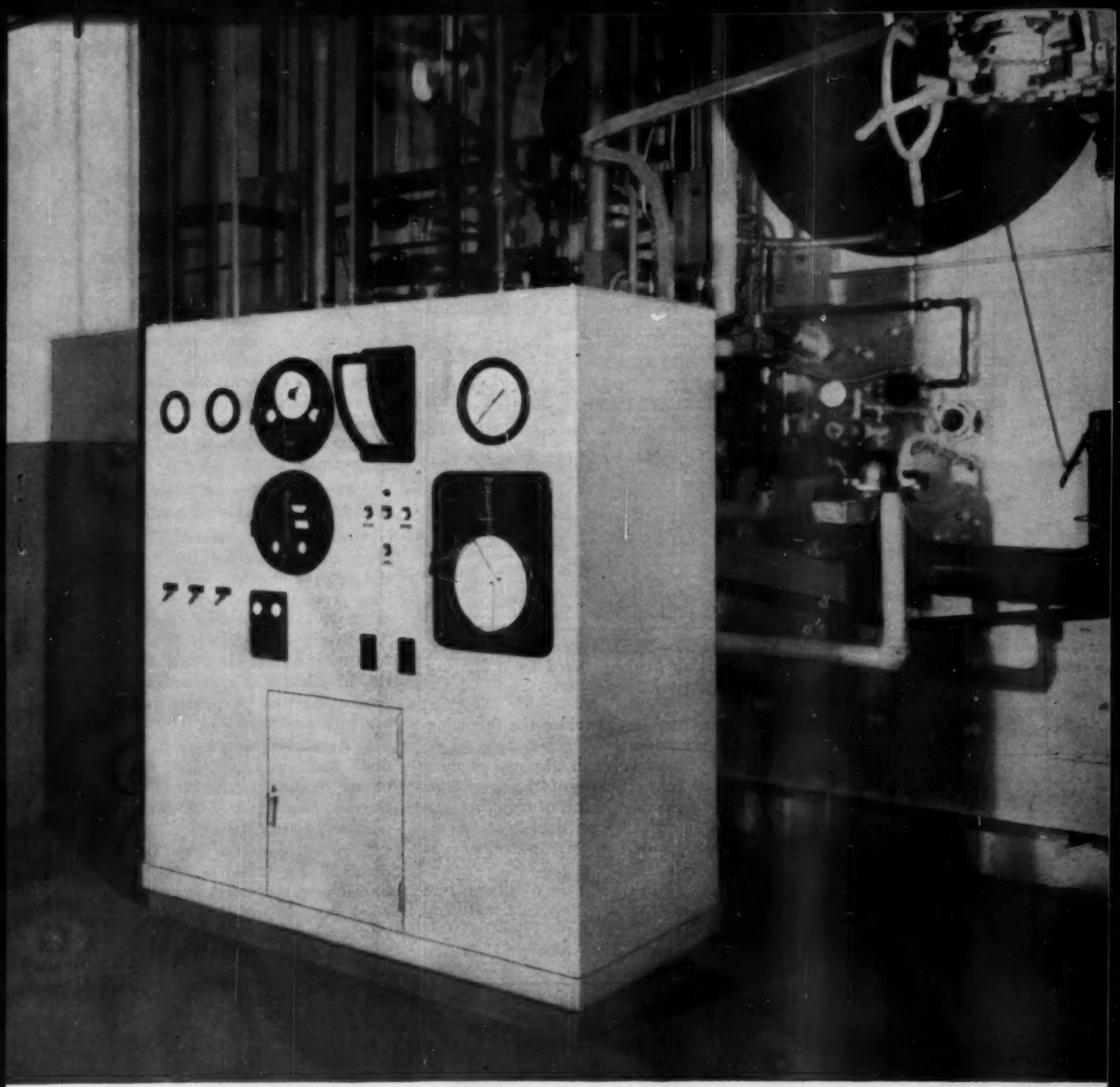
# New B&W Boilers Cut Heating Costs 22% for Country's 3rd Largest Building

**American Furniture Mart Corporation replaces 3 previous boilers with 2 B&W package units . . . Heats 29 Million cubic feet at fuel cost saving of 22%**

The American Furniture Mart dominating Chicago's skyline with a 17 story building topped by a 33 story tower . . . has 29 million cubic feet of space to be heated. It is the largest commercial building in the world devoted to a single industry, home furnishings. Throughout the year, it is the national purchasing center for thousands of retail stores, large and small, and at peak markets, upwards of 45,000 buyers and sellers shop its display spaces. The recent installation of two B&W boilers . . . in place of three previous units . . . provides all the steam necessary for this large heating job at a fuel cost saving of 22%. Additional economies can be realized because fuels can be switched in a matter of minutes



to use the fuel most economical at any given time. Moreover, these new boilers are fast steaming . . . put out plenty of heat in a hurry even after being turned off all night.

In addition to cutting fuel costs, a savings that will pay for the units in five years, these B&W package boilers cut space requirements in half and require fewer men to keep them in operation. It is interesting to note, too, that these boilers were installed during the height of the heating season . . . with minimum loss of heat to the building's occupants during the changeover period. Furthermore, management knows that any time in the life of the boiler — 10, 20 or 30 years hence — B&W's nation-wide service organization will be promptly and economically available if needed.

Providing the efficiency, economy, and service necessary to heat the country's third largest building economically is further evidence-in-action of dependable steam generation by B&W. Whatever your steam requirement . . . whatever your most economical fuel . . . B&W has the boiler best suited to your heating application. For information, contact your local B&W representative. He has all the facts on your area. The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

B&W — THE NATION'S LEADING MANUFACTURER OF INDUSTRIAL BOILERS

G-972-1B

B&W

THE BABCOCK & WILCOX COMPANY

BOILER DIVISION

# Trapping Standardization

## . . . steam trap standardization plus standardized hook-ups spell lower maintenance costs

An important weapon in the fight against rising maintenance costs is standardization. It can reduce the variety of maintenance problems and simplify those which remain.

Since we specialize in steam traps we'd like to offer some suggestions for a trapping standardization program. Such a program involves standardization on one make of trap and standardization of hook-ups.

### Trap Standardization

The advantages of standardizing on a single make of trap are important and can make a big difference in the cost and ease of repairs because—

1. You can carry a more complete stock of repair parts with a smaller inventory.

2. Maintenance personnel has the opportunity to become expert on one make rather than be "jacks of all traps."

3. As an exclusive user of one make of traps you become a preferred customer of your trap representative and can be sure of getting the best possible service.

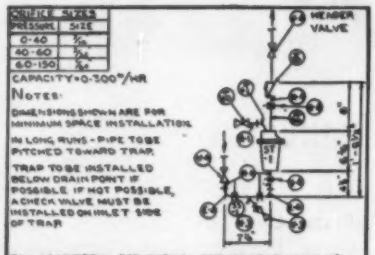
4. You can enjoy the advantages of standardized hook-ups.

### Standardized Hook-ups

Standardized hook-ups facilitate and reduce the cost of both original installation and maintenance. By adopting standards for the dimensions of all fittings, including nipples, each hook-up for a given size of trap is identical and can be fabricated in the pipe shop.

Unions should be used so that when a trap needs repair, the unions can be uncoupled, the trap lifted from the line and a spare carrying identical length nipples and half unions slipped into place. In as little as a minute or two a faulty trap can be replaced. The faulty trap can go back to the storeroom for repair when convenient and then be put into stock as a spare.

Figure 1 shows a typical standardized hook-up used by a major chemical manufacturer. Note how




BILL OF MATERIAL FOR TYPICAL STEAM TRAP HOOK-UP

| MARK | REQD | MAT'L | DESCRIPTION |
|---|---|---|---|
| ST-1 | 1 | | ½" STEAM TRAP - ARMSTRONG #81 |
| SS-1 | 1 | | ½" STRAINER - 250# W.S.P. - |
| V-4 | 2 | BRZ. | ½" GATE VALVE - SCRD - 300# W.S.P. - |
| V-20 | 1 | BRZ. | ½" GLOBE VALVE - SCRD - 200# W.S.P. |
| V-3 | 1 | BRZ. | ½" GATE VALVE - SCRD - 200# W.S.P. - |
| V-19 | 1 | BRZ. | ½" CHECK VALVE - SCRD - 200# W.S.P. - |
| E-4 | 2 | MAL. | ½" - 90° SCRD ELL - 2000# |
| L-41 | 1 | MAL. | ½" - 90° STREET ELL - 300# - |
| U-6 | 2 | MAL. | ½" UNION - 2000# |
| N-1 | 1 | STL. | ½" CLOSE NIPPLE - SCH. 80 - SEAMLESS ASTM A-53 |
| N-3 | 1 | STL. | ½" SHORT NIPPLE - SCH. 80 - SEAMLESS ASTM A-53 |
| N-4 | 6 | STL. | ½" SHORT NIPPLE - SCH. 80 - SEAMLESS ASTM A-53 |
| N-5/6 | 1 | STL. | ½" - 4 1/2 LG. NIPPLE - SCH. 80 - SEAMLESS ASTM A-53 |

*Fig. 1—Typical standardized installation hook-up used by a leading chemical manufacturer.*

the hook-up provides the following advantages:

1. Test valve in trap cap permits fast, easy checking of trap operation.

2. Strainer ahead of trap protects it against dirt and scale.

3. Blowdown valve in strainer provides easy cleaning.

4. Check valve in discharge line isolates trap when test valve is opened.

5. Shut-off valves and unions ahead of and following trap permit removal of entire trap from line.

*Fig. 2—Armstrong traps have only two moving parts—the lever assembly and the bucket. Nothing much to go wrong here.*

Another important consideration for getting the most from a standardization program is accessibility of the traps. Insofar as is possible, traps should be located so that they are convenient for inspection. The easier it is to locate and get at a trap, the less likelihood that it will be overlooked.

### What Make of Trap? (This is the Commercial)

Obviously, a trap standardization program shows the best results when the make of trap selected is the one that gives the best service. Naturally, we think the make should be Armstrong and fortunately a lot of trap users agree. Here are some of the advantages of standardizing on Armstrong that have been pointed out by these users:

1. *Armstrong traps work.* They don't leak steam and they do discharge condensate and air as fast as they reach the trap. And they work with any return system.

2. *Armstrong traps aren't "prima donnas."* They need no special care or coddling. Valve and seat are hardened chrome steel. Lever assembly and bucket are stainless steel and these are the only moving parts.

3. *Armstrong traps aren't "orphans."* You can *always* get parts and service from nearby Factory Representatives and stocking distributors.

4. *Armstrong traps are guaranteed.* If you're not *completely* satisfied you can return the traps for refund of purchase price.

### More Information

The 44-page Steam Trap Book (free on request) gives a lot more facts on trap selection and installation. Call your local Armstrong Representative or write **Armstrong Machine Works, 8101 Maple St., Three Rivers, Michigan.**

**ARMSTRONG STEAM TRAPS**



For more data circle 502 on Post Card

# Engineers' Preview

## OF NEWS AND COMING EVENTS IN THE POWER FIELD

NEW METHOD to prevent corrosion and hard deposits in coal-fired boilers is reported by Bituminous Coal Institute. Originally developed in England for use with oil-fired boilers, the method injects anhydrous ammonia into the gas passage between the economizer and the air heater.

Tests have been run by the Water and Light Dept of Lansing, Mich., and by Foster-Wheeler Corp in cooperation with Consumers Power Co of Jackson, Mich., and Allied Chemical Co. BCI reports that all tests showed a marked reduction in the acidity of fly ash deposits and in corrosion at the cold end of the boiler and stack.

Primary advantage of this ammonia-injection method is seen as the reduction of acidity in deposits.

**ALLIS-CHALMERS has introduced a new water-cooled power conversion silicon rectifier for large electrochemical and industrial applications. First of the new rectifiers, a 10,000-amp, 300-v unit, is being used in a midwestern electrolytic copper refining operation.**

ON the gas turbine front: Trans-Canada Pipe Lines Ltd has placed an order in excess of $2,500,000 with the Canadian Westinghouse Co for three 8500-hp gas turbines to act as compressor drives for a natural gas pipeline to the United States.

Gas turbine-powered fire trucks have been ordered by the cities of Seattle and San Francisco Fire Departments. Built by the American LaFrance Corp, these trucks will be powered by a 325-hp gas turbine made by the Boeing Industrial Products Division of Seattle. With turbine power these trucks will be able to accelerate from zero to 55 miles per hour in 34 seconds.

**EXIDE has signed agreements with 12 material handling equipment manufacturers to develop an adaptation of the Exide fuel cell to power electric industrial trucks.**

DURING 1960, Public Service Electric and Gas Co expects to spend about $140,000,000 to $150,000,000 for major construction work. This will be the fifth consecutive year the company's construction expenditures have exceeded $100,000,000 and will bring to more than a billion dollars the amount expended since 1951 for additions and improvements to plant and equipment.

**GRAVER TANK & Mfg Co, in conjunction with Western-Knapp Engineering Co, has been awarded an $8,094,200 contract to build surge tanks, penstocks and risers for the hydroelectric power plant at Oahe Dam, world's largest rolled earth dam, on the Missouri River near Pierre, S. Dakota.**

MAGNETIC BEARING systems have replaced conventional ball-and-jewel bearings in a line of single-phase 120/240-v watt-hour meters announced by Westinghouse. In these meters, disk-and-shaft assemblies are supported in space by the magnetic repulsion between two tiny rings of barium ferrite.

Mounted so that their fields are opposed, these rings serve as the two working surfaces of a frictionless thrust bearing. Supplying the slight lateral forces needed to restrict horizontal movement are stationary pins within graphite journals, which serve as guide bearings for the upper and lower ends of the shaft.

Among the advantages claimed for this design are: ability to withstand shock and vibration well above levels encountered during transit, immunity to thermal shock and environmental change, and, particularly, ability to serve for "at least 30 years" without maintenance.

**SUBURBAN POWER PACK is a small power transformer which has factory-mounted on its tank all necessary equipment to make a complete substation. It's a new development by Allis-Chalmers, and can be arranged for from one to four secondary feeders.**

SAN FRANCISCO is installing a 30-channel power-line carrier-current system for the new Hetch Hetchy hydrogenerating project at Cherry Dam in the Sierra Nevada. The system was built by General Electric.

Use of carrier-current on the 230-kv power lines provides all the necessary channels for telemetering, load control, transfer-trip relaying, directional-comparison relaying, supervisory control of switches and circuit

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breakers. It also provides the voice communication for the system's five stations.

All necessary control functions for operating the Cherry powerhouse, Canyon powerhouse, intake switchyard, and Warnerville substation are performed by operators stationed at Moccasin, a power station located 20 miles away.

**ANALYSIS of the education of the nation's nuclear engineers will begin in September under a grant made by AEC. This study is being sponsored jointly by the American Society for Engineering Education and the American Nuclear Society. Chairman of the study committee is Glenn Murphy, head of the Department of Theoretical and Applied Mechanics at Iowa State University.**

FEDERAL POWER COMMISSION has issued a 24-month preliminary permit to Chugach Electric Assn, Inc, of Anchorage, Alaska, for a proposed 18,000-kw hydroelectric project on Alaska's Kenai Peninsula.

**SCIENTISTS have shown for the first time how certain chemical compounds protect living cells against the effects of radiation, in experiments at the Argonne National Laboratory. The anti-radiation compounds are sulfhydryls (SH), so named because their active group contains sulphur and hydrogen. One of the most effective members of this group in preventing radiation damage in mammals is cysteine, an amino acid present in all protoplasm, a fundamental building block of living tissue.**

**Argonne's research indicates that the sulfhydryls work by reducing the lethal potency of a combination of oxygen and chemically active molecule fragments which team up to cause radiation damage in cells.**

USE of liquid petroleum gases to power diesel locomotives may be a reality. According to a report by the Engine Fuels and Lubricants Section of the Southwest Research Institute, there are design problems to be solved, but from present experimental data the use of LPG gases in combination with a dual injection system is both economically desirable and technically feasible.

**PLACEMENT of concrete at the Glen Canyon damsite on the Colorado River in northern Arizona last month triggered a new phase of construction of the great multipurpose structure which will result four years hence in a 700-ft-high barrier creating a 186-mile-long lake in the deep Glen Canyon of the Colorado. The dam is a key structure in the Colorado River Storage Project, which was authorized by Congress in 1956.**

MILESTONE in space-to-earth communications was achieved the other day when RCA tubes powered the first radio signals of a new "voice" of the Pioneer V planetoid back to earth from a distance of 8,001,000 miles. The transmission, made from the greatest distance over which man has ever received a radio broadcast, was powered by two identical RCA electron tubes each about the size of a large spool of thread.

This space probe, launched from Cape Canaveral, has been gathering technical facts on the environment of deep space. Its transmitter radios information on the location and speed of the vehicle, its temperatures, as well as information about radiation and magnetic fields. The 150-watt transmitter is the most powerful radio ever sent aloft in an American deep-space probe.

**HENNEY KILOWATT, an electric automobile made by Eureka Williams Corp for its Henney Motor Co division, is powered by 36 two-volt batteries, 18 under the front hood and 18 in the rear. In addition there are 12 volts for lighting and for operating the turn signals and windshield wipers. Top speed is 35 mph. Range is flexible, about 40 miles a day if run constantly and 50 to 60 miles if operated at moderate speed with frequent stops.**

**The Kilowatt is dedicated to the utility industry and none will be sold to the public by Henney. Tentative orders were placed for 76 of the cars in advance of production, at $3500 each. Henney expects to be able to reduce this price when production is in the hundreds.**

HIGH TEMPERATURES and corrosive atmospheres no longer limit the use of fabric filters in dust collecting applications. Bag-type dust collectors made from Fiberglas treated with Dow Corning silicones will reportedly operate continuously at temperatures up to 600 F.

**IBM has perfected two teleprocessing data machines — electronic devices that talk to one another in computer language via regular toll telephone calls. The IBM 7701 magnetic tape transmission terminal sends business and scientific data at the rate of 150 characters or thirty words a second — fifteen times as fast as human speech. The IBM data transceiver equipped with a dial-up telephone feature can transmit ten 80-column punched cards a minute.**

**In each case a twin device at the other end of the telephone circuit, which may be across the country, automatically recreates the original magnetic tape or punched card data. Both of these terminals are also capable of operating over telegraph lines.**

WATER QUALITY Measurement and Instrumentation Symposium will be held Aug. 29, 30 and 31 at the Hotel Sinton in Cincinnati. Sponsors are the Taft Sanitary Engineering Center and the Division of Water Supply and Pollution Control of the U. S. Public Health Service.

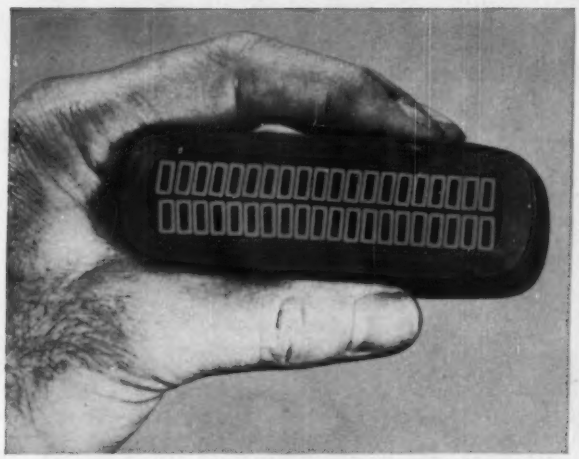
Instrument Society of America's Fall conference and exhibit will be held in New York City, Sept. 26–30. This will be the 15th annual meeting of the Society.

**FUEL CONSUMPTION for the 12-month period ending March 31 totaled 171,106,229 tons of coal, 88,458,633 barrels of oil, and 1,662,026,681,000 cu ft of gas. The Federal Power Commission reports that this represents increases of 7.7 per cent for coal, 3.5 per cent for oil, and 18.9 per cent for gas as compared with the year ending March 31, 1959. The Commission also reports that for the year ending March 31, 1960, electric utilities produced 725,898,774,000 kwh, or 10.1 per cent more than for the previous 12-month period.**

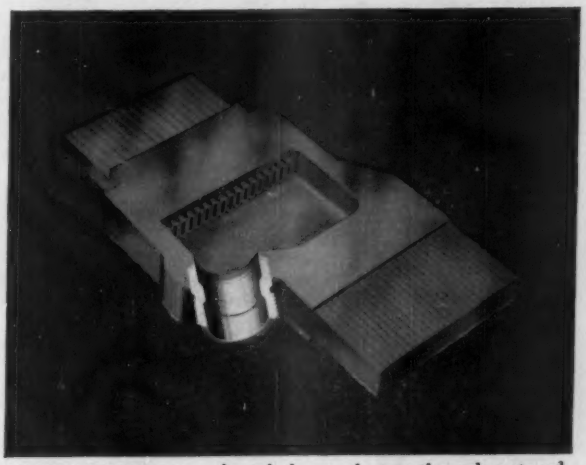
# ANACONDA® COPPER METALS

## FOR THE ELECTRICAL INDUSTRY

THE AMERICAN BRASS COMPANY • WATERBURY 20, CONN.



**CROSS-SECTION** of stator bar showing arrangement of 40 rectangular copper tube conductors which carry current and coolant—transil oil in present designs, water in units being planned.



**LIQUID COOLANT** enters the tubular conductors through a strand header at end of stator bars. *Above:* Header cut open to show construction. *Below:* Headers being installed on stator bars.

### DO YOU KNOW THESE ELECTRICAL COPPERS?

**ANACONDA LEADED COPPER-126** (Cu 99.00%, Pb 1.00%). Combines high conductivity, averaging 99% I.A.C.S., annealed, with excellent machinability, 80 on a scale in which Free-Cutting Brass is 100. Available in strip, rod, and bar form.

**ANACONDA TELLURIUM COPPER-127** (Cu 99.49%, Te 0.50%, P 0.01%) offers high conductivity averaging 95% I.A.C.S., annealed, and machinability rating of 80. Available in rod, bar, extruded shapes, and die-pressed forgings. Particularly valuable where hot forging or hot working is combined with machining.

**WRITE FOR** Publication C-25, "Anaconda Copper for Electrical Conductors."

## Liquid-cooled tubular copper conductors for stators can double generator ratings

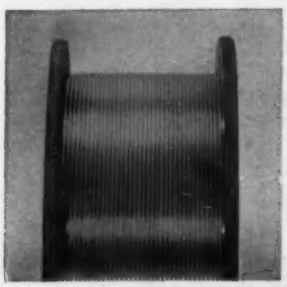
In designing turbine-generator units for the ever larger blocks of power needed by the electric utility industry, General Electric scored a major advance by liquid-cooling the conductors in generator stator bars. The problem has been to increase generator ratings without increasing their physical size beyond the limitations of transportation.

Occupying no more space than conventionally cooled 156,250-kva units of a few years ago, the first conductor-cooled G-E generator has a rating of 260,000 kva. And this new design is a significant step toward doubling generator ratings without an appreciable increase in frame size. It points the way to much larger machines – possibly as high as 750,000 kva.

The French Small Tube Division of The American Brass Company has recently supplied rectangular copper tube conductors for another generator of this design, which will have a rating of 221,000 kva. The tube was shipped in long coils.

For technical assistance in the design of hollow conductors, write The American Brass Company, Waterbury 20, Connecticut. 5970

## Anaconda Welding Wire now available on 25-lb. spools for inert-gas consumable-electrode welding



For welding copper bus conductors and other fabrication by inert-gas consumable-electrode processes, Anaconda Copper-372 Welding Wire is now available in 25-lb. expendable spools. Carefully cleaned and layer-wound (left), it is shipped in a special carton. Sizes regularly available on spools: .035", .045", 1/16", 3/32" and 1/8". Other Anaconda copper-alloy welding alloys, such as Everdur®-1010 and Ambraloy -928, also are supplied on spools. For detailed information on Anaconda Welding Rods, write for Publication B-13.

For more data circle 503 on Post Card

# Tracers

COMMENT, OPINION, AND NEWS ABOUT PEOPLE

▶ **W. E. Hoffman** recently asked in these columns about a balloon device made of Neoprene for installation in coal hoppers to break jam-ups. Neither he, nor we, could come up with the name of the manufacturer. But now one of our readers in Électricité de France, writing from Porcheville (S. & O.), supplies this information:

> Here is an answer to W. E. Hoffman's question. The balloon device to break jam-ups in coal hoppers is called Clouth cushions and is manufactured by Ets Franz Clouth, Rheinische Gummiwarenfabrick, Aktiengellschaft Cologne, Western Germany. Though it's a rather costly device, it is effective; but the cushions must be fixed at places determined by experienced engineers, since the results are very different according to locations. The inflating sequence is important, too.

On this same problem, reader **C. W. Dagner** of California suggests that there might be merit in the idea of adapting boots similar to the de-icing boots on the leading edge of airplane wings.

▶ Problem of mussels and controlling their growth has been brought up in this department. Now **R. C. Hadley** of Stearns-Roger of Denver, has this helpful experience to share with interested readers:

> It so happens that we have just completed the engineering on a power plant in South America faced with this problem. The mussels in this instance were *mytulis etulii* and *mytulis californianus*, which have been found sensitive to heat treatment.
>
> If the circulating water system is arranged for recirculation, the temperature can be raised quickly and easily to approximately 105 F throughout the system, which effects a 100 per cent kill within 60 minutes. This should be done at frequencies that prevent the growth beyond the very formative early stages while the mussel is perhaps still invisible. It then prevents any deposition or growth whatsoever. There have been found to be growth seasons depending on latitude and food supply.
>
> There are some precautions in the turbine-generator system also to be taken. If generator cooling is by circulating water, load must be reduced during this period and oil temperatures must be watched carefully if it is similarly cooled. If the circulating system is physically long, there may be a thermal lag which introduces danger of over-running the 105 F before the control can be checked by admission of fresh sea water.
>
> All of these points are peculiar to each installation but simple in operation, and the user will find that he has simply and cheaply solved the mussel problem.

▶ **Alfred W. Rowley,** engineer in a plant in New York, poses a water riser problem. Perhaps you have had experience which is pertinent. Rowley writes:

> We have a 50,000-gal Pittsburgh-Des Moines steel water tower that has developed leaks in the riser. Replacement of 2-ft-diam riser pipe is costly and I would like to know if lining with glass cloth and polyester resin would be feasible.

How would you answer this question?

▶ Large-scale conversion of ocean water to fresh water is the ultimate solution to the nation's growing need for more water, say **Arthur D. Little** researchers in Boston, but the cost of such a process is still too high. Typical distillation plant for conversion of inland, brackish waters or ocean water would boost the cost of water to a little over $1 per 1000 gallons, Little reports. Current costs for water in the U. S. average about 30 cents per 1000 gallons. Current rate of water consumption is running around 250 billion gallons a day.

▶ Society of American Military Engineers has awarded the Moreell Medal to Commander **John G. Dillon,** Director, Utilities Div, Bureau of Yards and Docks, Navy Dept. Dillon was cited for the most outstanding contribution to military engineering by a member of the Civil Engineer Corps, U. S. Navy.

**Philip Sporn,** president of the American Electric Power Service Corp, has been given a Conservation Service Award by the Department of the Interior, for his services as a proponent of conservation of the fuels of the U. S.

**Frederick D. Braddon,** creator of the gyro-compass that guided the atomic submarines *Nautilus* and *Skate* under the ice cap of the North Pole, has been given the Elmer A. Sperry Award. This is a joint honor given by ASME, AIEE, Society of Automotive Engineers, and Society of Naval Architects and Marine Engineers.

The St. Lawrence Power and Seaway Project has won ASCE's Outstanding Civil Engineering Achievement for 1960. Receiving plaques were: **W. Ross Strike,** 1st vice-chairman of the Hydro-Electric Power Commission of Ontario; **A. G. Murphy,** chief engineer of the St. Lawrence Seaway Authority; **Robert Moses,** chairman of the Power Authority of the State of New York; and **Martin W. Oettershagen,** who is deputy administrator of the St. Lawrence Seaway Development Corp.

New president of the American Society for Engineering Education is **Eric A. Walker,** president of Pennsylvania State University.

**Melbourne A. Forrest** has been named a vice-president of Burns and Roe, Inc.

**E. G. Paulson** has joined the Engineering Dept of Consolidated Water Power & Paper Co in Wisconsin Rapids, Wis., where he will serve as a mechanical engineer. He comes to the company from Allied Paper Co.

## *Peabody Coal Generates Much of the Electricity That Brings You the Comforts and Conveniences of Modern Living*

Your family refrigerator makes possible an abundant variety of fresh, tasty foods and beverages all year 'round. And every year, 526 pounds of coal are used to generate the electricity that runs this dependable family store. In our homes, offices and plants . . . in countless ways . . . coal serves us by generating economical electrical power. *Coal* generates more electricity than all other fuels and water power *combined*, and Peabody Coal Company . . . with over two billion tons of proven reserves . . . supplies many of the nation's leading electric utilities that bring you this power . . . at a price you can afford to pay. The next time you enjoy a crisp, appetizing salad . . . or turn on a light . . . or watch television . . . think of *coal* and the great electric utilities that serve *you*.

*Learn more facts about Peabody Coal . . . its importance to the nation's economy and your business. Send for Peabody's new FREE booklet, "COAL . . . ANCIENT STOREHOUSE OF MODERN LIVING." Write Department PE.*

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# new Yarway Unit Tandem Valve for blow-off service up to 665 lbs. WSP ...provides proven Yarway Unit Tandem dependability for medium pressure installations. Streamlined, light in weight, easy to operate, tight sealing, with minimum maintenance.

**Ask for free Bulletin B-435, Supplement A**

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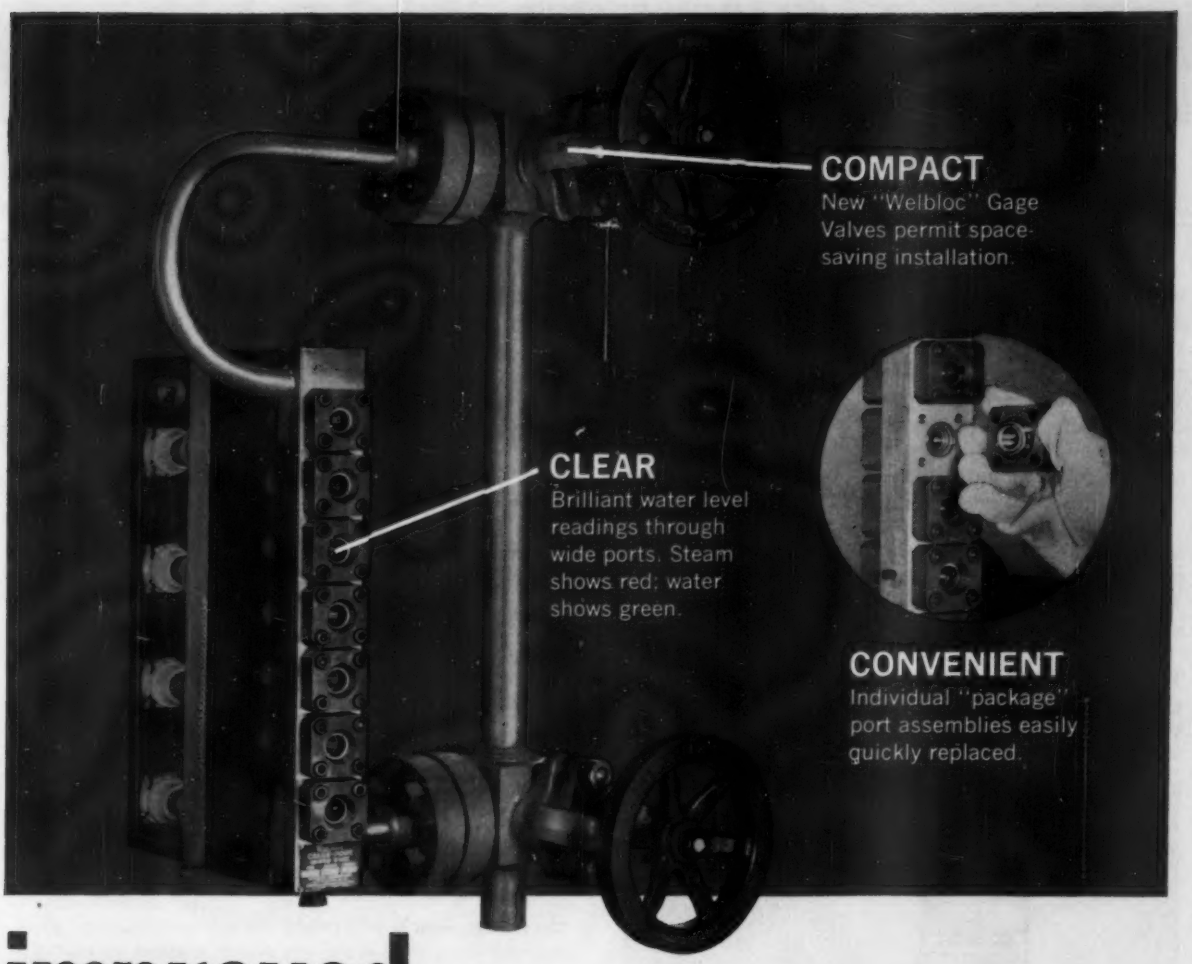
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY
*A MARK OF QUALITY IN STEAM ENGINEERING*

TIGHT
Sealing valve is time-proven Yarway Seatless design.
TOUGH
Blowing valve features stellite-faced disc and integral stellite seat.
TRIM
Both valves, mounted together, permit more compact piping with reduced weight.

A FEW OF THE MANY SATISFIED USERS: U. S. Sugar Corp. • [illegible] Mfg. Co. • [illegible] Paper Co. • R. J. Reynolds Tobacco Co. • Pulp and Paper Co., Columbia, S. A. • Western Electric Co. • Cornell University


COMPACT
New "Welbloc" Gage Valves permit space-saving installation.
CLEAR
Brilliant water level readings through wide ports. Steam shows red; water shows green.
CONVENIENT
Individual "package" port assemblies easily quickly replaced.

# improved Yarway Color-Port Gages for medium pressure boiler service to 1050 psi*—with new "Welbloc" Gage Valves—offer you reduced maintenance, increased operational time, brilliant red and green level readings.

*High pressure design for pressures to 3000 psi also available

**Write for new Yarway Bulletin WG-1815**

**YARNALL-WARING COMPANY,** 100 Mermaid Ave., Philadelphia 18, Pa.

BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY

*A MARK OF QUALITY IN STEAM ENGINEERING*

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Now ALCOA has developed a new product, DUOTRACE,* to expand the design range of integrally traced piping systems. DUOTRACE contains not one but *two* trace chambers plus a product chamber in a single extruded aluminum pipe. This makes DUOTRACE the perfect solution to the need for recirculating tracing systems.

*Trademark of Aluminum Company of America

Today, the ingenuity of process industries designers has indicated intriguing new areas of potential use for both UNITRACE and DUOTRACE. Consider, for instance, the process economies which can result from the substitution of either UNITRACE or DUOTRACE for unit heat exchangers and preheaters.

Here you see an outstanding example of the way in which ALCOA is putting over 40 years of process industries experience to work to make aluminum your good design habit. You are invited to share that experience—through a series of engineering conferences which ALCOA is holding this year in a number of major cities. Your local ALCOA sales office will be happy to furnish details.

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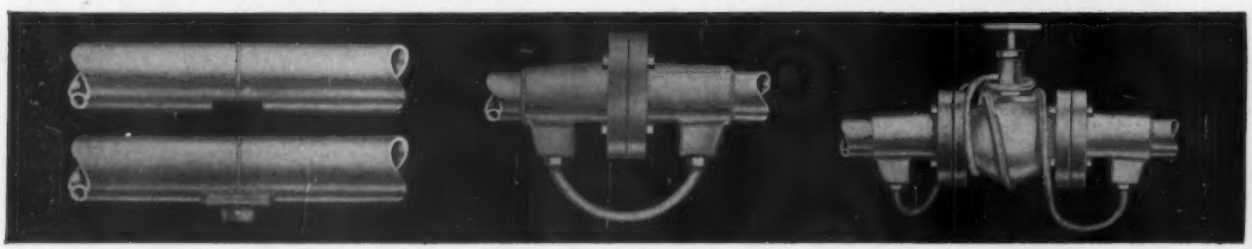
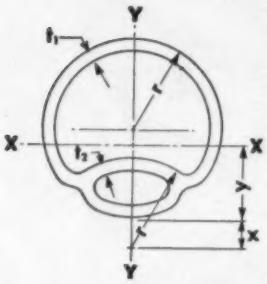
**The development of DUOTRACE** has opened broad new areas of design exploration in the field of heat transfer. By adding a second trace chamber to the one previously available in UNITRACE, DUOTRACE permits recirculation of the trace fluid. This opens up a whole new area of heat transfer design. Not the least of the possibilities is this: certain types of heat exchangers may now be extruded as single units. The cost savings implicit in such a unit are almost staggering. Alcoa engineers will be happy to assist you in exploring such design innovations in your own plant or process.

**Fittings and connections for UNITRACE and DUOTRACE: Unflanged connections** can be made easily and effectively with the special UNITRACE Trace Cap. As illustrated, trace chambers in adjoining sections are cut back and a circumferential weld is made to seal the product chamber. The cut back trace section is then covered with a UNITRACE Trace Cap welded in place with 4043 weld wire. Simple, efficient **flanged connections** utilize special UNITRACE flanges designed to accommodate both trace and product chambers. Jumper connections are used to carry the trace across the connection, and special impingement plates in the flange shield the product chamber from erosion as steam passes through the flange. **Valves, pumps and other fittings** can be incorporated into the traced systems by using UNITRACE flanges which mate with all 150-lb ASA flanges, valves and pumps. UNITRACE and DUOTRACE systems accommodate standard preformed pipe insulation.

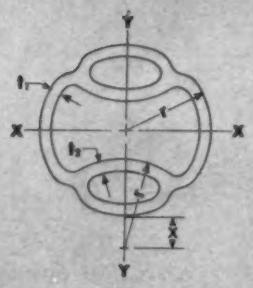


UNFLANGED CONNECTIONS FLANGED CONNECTIONS VALVES AND FITTINGS




| | Unitrace Sizes | 1 in. | 1½ in. | 2 in. | 3 in. | 4 in. | 6 in. | 8 in. |
|---|---|---|---|---|---|---|---|---|
| Axis XX | Moment of Inertia (I) in.⁴ | .09 | .34 | .72 | 2.71 | 6.52 | 31.82 | 81.82 |
| | Radius of Gyration (R) in. | .37 | .58 | .72 | 1.09 | 1.42 | 2.12 | 2.78 |
| | Section Modulus (S) in.³ | .13 | .34 | .56 | 1.42 | 2.65 | 8.73 | 17.22 |
| Axis YY | Moment of Inertia (I) in.⁴ | .09 | .33 | .70 | 2.65 | 6.36 | 29.72 | 76.70 |
| | Radius of Gyration (R) in. | .37 | .57 | .71 | 1.08 | 1.40 | 2.05 | 2.69 |
| | Section Modulus (S) in.³ | .14 | .34 | .59 | 1.52 | 2.83 | 8.97 | 17.79 |

| Sizes | 1 in. | 1½ in. | 2 in. | 3 in. | 4 in. | 6 in. | 8 in. |
|---|---|---|---|---|---|---|---|
| r | .657 | .950 | 1.187 | 1.750 | 2.250 | 3.312 | 4.312 |
| $t_1$ | .133 | .145 | .154 | .170 | .187 | .280 | .322 |
| $t_2$ | .145 | .163 | .174 | .185 | .200 | .307 | .354 |
| x | .133 | .344 | .406 | .625 | .813 | 1.500 | 2.000 |
| y | .61 | .87 | 1.08 | 1.59 | 2.03 | 2.98 | 3.87 |




| | Duotrace Sizes | 1 in. | 1½ in. | 2 in. | 3 in. | 4 in. | 6 in. | 8 in. |
|---|---|---|---|---|---|---|---|---|
| Axis XX | Moment of Inertia (I) in.⁴ | — | — | .80 | 3.06 | 7.53 | — | — |
| | Radius of Gyration (R) in. | — | — | .74 | 1.12 | 1.46 | — | — |
| | Section Modulus (S) in.³ | — | — | .68 | 1.75 | 3.35 | — | — |
| Axis YY | Moment of Inertia (I) in.⁴ | — | — | .67 | 2.59 | 6.29 | — | — |
| | Radius of Gyration (R) in. | — | — | .68 | 1.03 | 1.33 | — | — |
| | Section Modulus (S) in.³ | — | — | .57 | 1.48 | 2.80 | — | — |

| Sizes | 1 in. | 1½ in. | 2 in. | 3 in. | 4 in. | 6 in. | 8 in. |
|---|---|---|---|---|---|---|---|
| r | — | — | 1.187 | 1.750 | 2.250 | — | — |
| $t_1$ | — | — | .154 | .170 | .187 | — | — |
| $t_2$ | — | — | .174 | .185 | .200 | — | — |
| x | — | — | .531 | .843 | 1.125 | — | — |
| y | — | — | — | — | — | — | — |

| Unitrace-Duotrace Sizes | 1 in. | 1½ in. | 2 in. | | 3 in. | | 4 in. | | 6 in. | 8 in. |
|---|---|---|---|---|---|---|---|---|---|---|
| Product Area (in.²) | .64 | 1.68 | 2.72 | 2.36 | 6.38 | 5.67 | 10.84 | 9.74 | 24.64 | 42.79 |
| Trace Area (in.² each) | .10 | .16 | .35 | .22 | .98 | .61 | 1.86 | 1.07 | 2.85 | 5.12 |
| Metal Area (in.²) | .65 | 1.03 | 1.39 | 1.46 | 2.28 | 2.46 | 3.24 | 3.53 | 7.05 | 10.60 |
| Weight (lb/ft) | .77 | 1.22 | 1.66 | 1.72 | 2.71 | 2.89 | 3.85 | 4.16 | 8.38 | 12.60 |
| *Min. Bend Radii (in.) | 5 | 8 | 10½ | 10½ | 17 | 17 | 24 | 24 | 36 | 48 |
| Wetted Perimeter (in.) | | | | | | | | | | |
| Product | 3.35 | 4.92 | 6.31 | 6.28 | 9.68 | 9.65 | 12.72 | 13.02 | 18.63 | 24.75 |
| Trace (each) | 1.49 | 1.71 | 2.40 | 1.87 | 4.13 | 3.22 | 5.32 | 4.23 | 6.75 | 9.63 |
| Fitting Weights (lb) | | | | | | | | | | |
| Trace-Caps | .102 | .126 | .240 | .13 | .464 | .40 | .674 | .55 | 1.67 | 2.92 |
| Elbows | .706 | 1.347 | 2.111 | 2.65 | 5.244 | 6.59 | 9.649 | 11.68 | 27.76 | 52.51 |
| Impingement Plates | .024 | .039 | .057 | | .101 | | .162 | | .22 | .34 |
| Stub Ends | | | | .65 | | 1.50 | | 2.13 | | |
| Terminal Casting | | | | .50 | | 1.12 | | 1.75 | | |

| | 1–2 in. | 1½–2½ in. | 2–3 in. | 3–4 in. | 4–6 in. | 6–8 in. |
|---|---|---|---|---|---|---|
| Adapter Flanges | 2.419 | 3.816 | 4.774 | 7.216 | 11.106 | 19.23 |

(Note: UNITRACE values are indicated in clear areas in the table above. DUOTRACE values are shown in the shaded areas.)
*Unitrace may be bent in any direction to these radii provided reasonable tooling is employed.


Aluminum Company of America, 876-G Alcoa Building, Pittsburgh 19, Pa.
Please send me the following literature covering Alcoa Aluminum for tubular products and other uses in the process industries:

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☐ 10418 Alcoa Unitrace: Combines Piping and Tracing in One Unit
☐ 514 Alcoa Duotrace Technical Report
☐ 10270 Alcoa Utilitube
☐ 10460 Process Industries Applications of Alcoa Aluminum
☐ 11453 Solving Refinery Corrosion Problems with Aluminum
☐ 20849 Resistance of Aluminum Alloys to Weathering and Resistance of Aluminum Alloys to Chemically Contaminated Atmospheres
☐ 20437 Aluminum Alloy Heat Exchangers in the Process Industries
☐ 19416 Brazing Alcoa Aluminum
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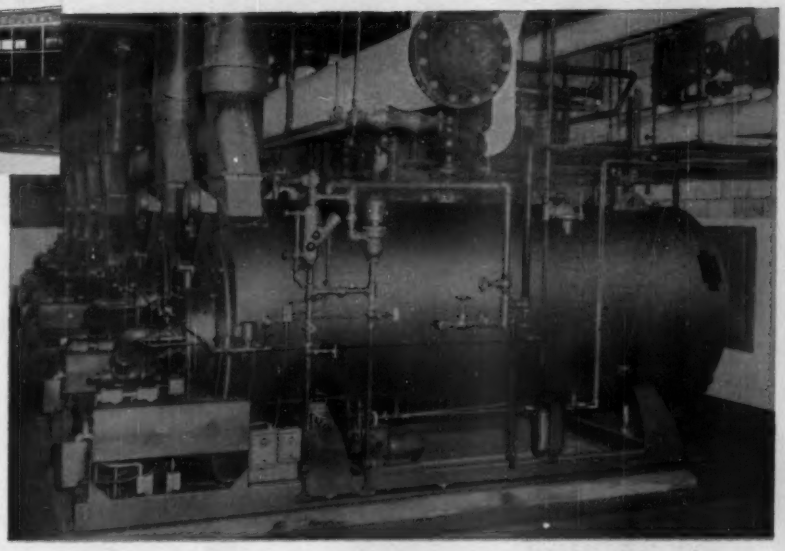
*never less steam than you should have!*



One of the largest producers of graders, roadscrapers and rolling equipment, Galion Iron Works & Manufacturing Co., has six 125 HP Cyclotherms now operating, plans to add a seventh and eighth as steam demands increase. Automatic operation has been the big factor in helping Cyclotherm make the grade with the graders!

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Cyclotherms operate with automatic efficiency. On 15 to 60 HP units, burner automatically shuts down when steam demands are satisfied, automatically turns on when more steam is needed. On 80 to 750 HP units, modulation controls regulate firing rate from 30% to 100% of rated capacity, without loss of efficiency. Operation stops automatically if firing sequence is interrupted and unit "fails safe."

### BUILT TOGETHER TO WORK TOGETHER

Cyclotherm burner and boiler are built together to work together — one manufacturing responsibility back of the entire equipment. Units are fire-tested at factory, shipped ready to operate. Cyclotherms are up to 1/3 smaller than other package boilers of same capacity. Installation is easy—no costly stack, no excavation, no foundation.

### "CYCLONIC COMBUSTION"

"Cyclonic Combustion"—Cyclotherm's patented combustion principle—guarantees a minimum of 80% efficiency, meets all state requirements, conforms to A.S.M.E. and National Board standards, carries Underwriters' Laboratories label. Steam Generators from 15 HP to 750 HP, burn oil and/or gas. Hot Water generators in 10 capacities, from 670, 000 BTU per hr. to 6,700,000 BTU per hr.

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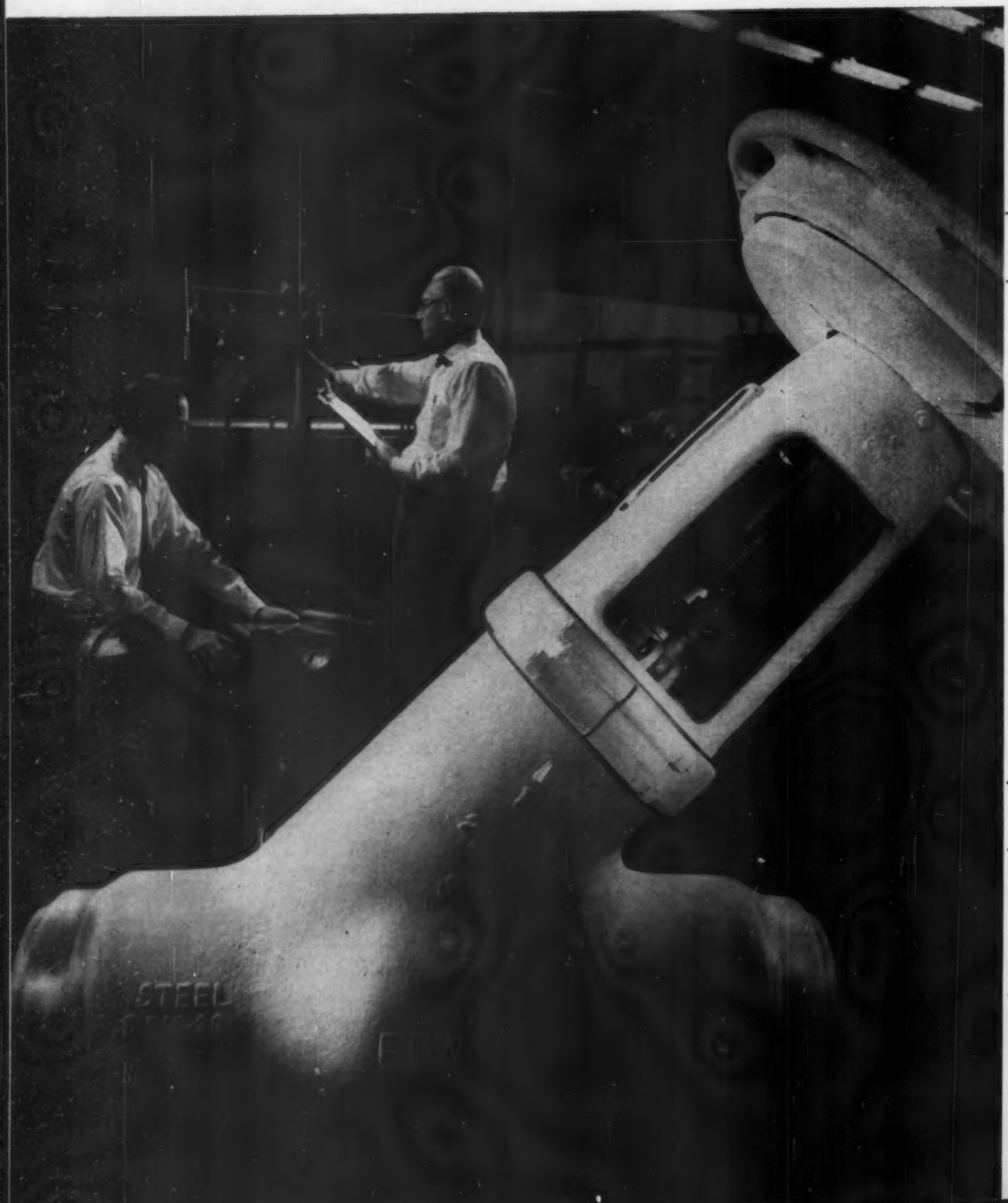
# How Edward Valve Research



# Reduced Pressure Drop 70%

**Power industry advances in unit size created a need for large, high pressure steel valves (ten inch size and larger, 1500 lb class and higher) with three basic qualities: 1. Permanent tight seating; 2. Capacity to handle high flow rates being encountered in new, high pressure plants; 3. Reduced downtime through simplified maintenance. Edward researchers developed the Flite-Flow* design to satisfy that need. This is their story.**

In 1951 Edward had already developed large cast steel globe valves with excellent dependability and repairability. Long experience in building inclined stem Y-type valves in small sizes indicated that this configuration offered a more efficient flow path. Edward research engineers set out to learn whether sufficiently strong pressure containing structures might be built in the Y-type design in larger sizes. They also sought to find out if pressure drop could be reduced sufficiently to make such a valve practical for high pressure power plant services.

The project consisted of three steps:

**1. INTERNAL CONTOUR DESIGN**—Flow tests were conducted with a series of plastic models. Early in the testing program it was observed that flow capacity was not always directly related to the size of the opening. Reduction of turbulence proved to be even more important. This eventually led to subtle internal contour changes to pre-shape the flow before passing through the valve seat. More material was added to certain internal areas to gain additional structural strength.

**2. DISK GUIDING TESTS**—To compensate for the angular position of the stem-disk assembly tests were conducted to determine whether conventional three-point guiding used in vertical stem Edward valves would be adequate for the inclined stem design. Experiments suggested that four equally spaced guiding surfaces would be superior. This is important in floating disk types such as check or stop-check valves where disk-piston assembly must seat automatically.

**3. STRUCTURAL STRENGTH**—The usual weakness of a Y-type pressure containing vessel received much attention. Optimum valve contour as determined by flow testing permitted use of a structural member in the flow passage at the downstream side of the seat port. This structural member provides strength exactly where needed without significant increase in pressure drop. Introduction of this segment to the valve body casting without sacrifice in pressure drop was a significant achievement.

**RESULTS:** This program covered a period of six years. Tests of the completed design were most gratifying. Structural stability, a major problem, was excellent. Strain gage and brittle lacquer tests of finished valve bodies showed stresses well within acceptable limits. Pressure drop reduction amounted to as much as 70 per cent from best previous globe valve experience. Extended tests of finished product at pressures and temperatures above rating showed no operating weaknesses. The Flite-Flow is truly a dependable, repairable, low pressure drop valve.

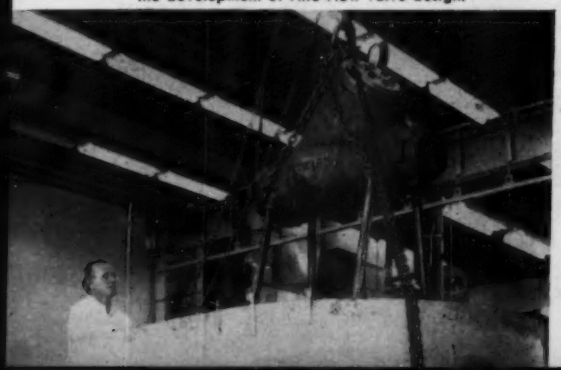
Edward builds a complete line of forged and cast steel valves from ¼" to 24" for industrial, marine, petroleum and technological services. For more detailed information, contact your Edward Representative, or write Edward Valves, Inc., 1202 West 145th Street, East Chicago, Indiana. Subsidiary of Rockwell Manufacturing Company. Represented in Canada by Lytle Engineering Specialties, Ltd., 438 St. Peter Street, Montreal.

*T.M. Reg. U.S. Pat. Off.

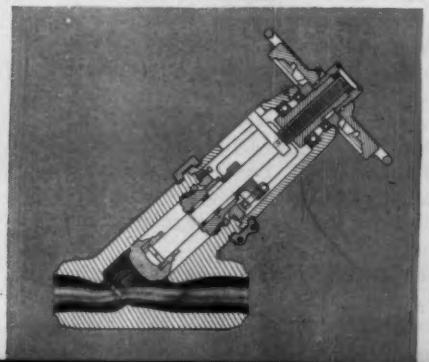
EDWARD STEEL VALVES
another line product by
ROCKWELL

◀ W. G. Lunt, research engineer, and E. B. Pool, chief research engineer, study flow phenomena in plastic half-model of tentative Flite-Flow design.

▼ Edward research team lowers experimental valve into test furnace where it is subjected to prolonged extremes of heat and pressure. This was one of the final steps in the development of Flite-Flow valve design.



Cutaway view of Flite-Flow valve showing how inclined stem Y-type valve configuration has been adapted to larger size units for power plant services. This internal contour design enabled Edward research engineers to substantially reduce pressure drop.



HELPFUL WATER CONDITIONING DATA FROM BETZ

# WATER . . . IN AIR

**■ Failure of equipment and excessive maintenance costs will result unless proper methods of chemical feed and control are employed**

AIR CONDITIONING is a development of this modern age that pays for itself. The trend for air conditioning continues upward at a rapid rate. Theaters, department stores, practically all kinds of commercial establishments and public buildings have adopted air conditioning for comfort. The trend toward industrial air conditioning is also on the rise. In earlier years, only those industries that required close control of temperature and humidity for product quality adopted air conditioning. Now, however, the desire to maintain employee efficiency, as well as production efficiency are additional factors that make air conditioning a wise investment. Achieving the benefits of air conditioning, and assuring payout on this investment is largely contingent upon one important factor—water.

Initially, little attention was given to the water used in air conditioning systems. However, it was soon found that water plays an important role in the proper functioning of air conditioning systems. The system piping, the heat exchangers, and all parts exposed to water may be affected by corrosion, by scale or sludge accumulation and by slime formation. These problems can lead to the loss of heat transfer, restriction of water flow, inefficient operation and excessive maintenance costs; or in severe cases to failure of the equipment and high replacement costs.

## Water Circuits

Air conditioning installations are so varied as to components that a number of water circuits are possible. Figure 1 illustrates a simplified flow sheet of a central air conditioning system used in large installations. The three water circuits encountered are the chilled water which is in a closed circuit, the spray water which serves the air washer and the tower water which serves to condense the refrigerant. Figure 2 illustrates a simplified diagram of a small air conditioning system served by a reciprocating compressor and an evaporative condenser. The only water circuit is in the evaporative condenser. Although there are many types of arrangements possible, each of the water circuits must be given proper consideration to avoid serious problems.

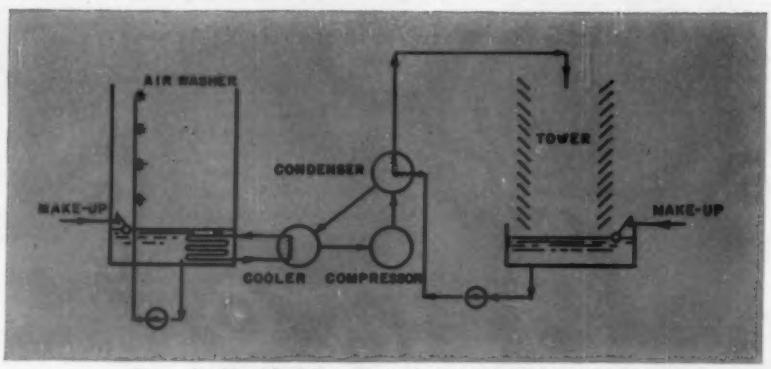



Figure 1—Simplified flow sheet of a central air conditioning unit with a closed chilled water circuit.

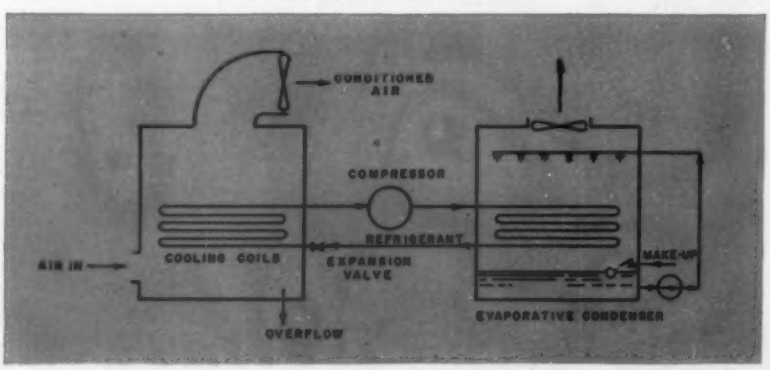



Figure 2—Simplified diagram of a small air conditioning system with one water circuit.

## Water Problems

### Corrosion

Most waters are corrosive to metals because of the presence of oxygen in the water. In air conditioning systems the water comes in contact with large volumes of air and therefore the water is continuously saturated with oxygen. Often the air may be contaminated with other corrosive gases such as sulfur dioxide and carbon dioxide which are present in flue gases discharged from smokestacks. These gases dissolve in water to form acids. The combination of dissolved oxygen and the acid formed from sulfur dioxide causes a particularly severe corrosion problem. Other factors, such as the presence of dissimilar metals, high concentrations of dissolved mineral salts—particularly chlorides, deposits of slime, scale, dirt, etc. all add to the corrosive action of the water.

### Scale

In areas where the water is high in hardness, scale formation frequently is the principal problem. The calcium and magnesium salts naturally present in the water are primarily responsible for scale formation. If large amounts of these salts are present in the water, they will form deposits when the water is heated or concentrated by evaporation. The major problems produced from such deposits are loss in heat transfer, increased head pressures and clogged spray nozzles, all of which result in loss of efficiency.

Scale formation usually refers specifi-

cally to the deposits formed from the calcium and magnesium salts. Other deposits such as slime, corrosion products, dirt and debris, however, can produce the same adverse effects.

**Slime and Algae Growths**

Slime and algae growths in air conditioning equipment are primarily the result of air-borne organisms. The large ratio of air to water in air washers, evaporative condensers and cooling towers, provides the opportunity to continuously inoculate the water with bacteria, fungi and algae. Heavy growths can develop in the presence of an adequate food supply and the favorable temperatures that exist in these systems. These biological growths can seriously interfere with heat transfer, clog spray nozzles and screens as well as cause corrosion. Growths of this type cause inefficient operation of the mist eliminator section in air washers and lead to "water throw" into the duct work and out into the air conditioned area. Stagnant water in the ducts, and biological growths in general can impart foul odors to the air.

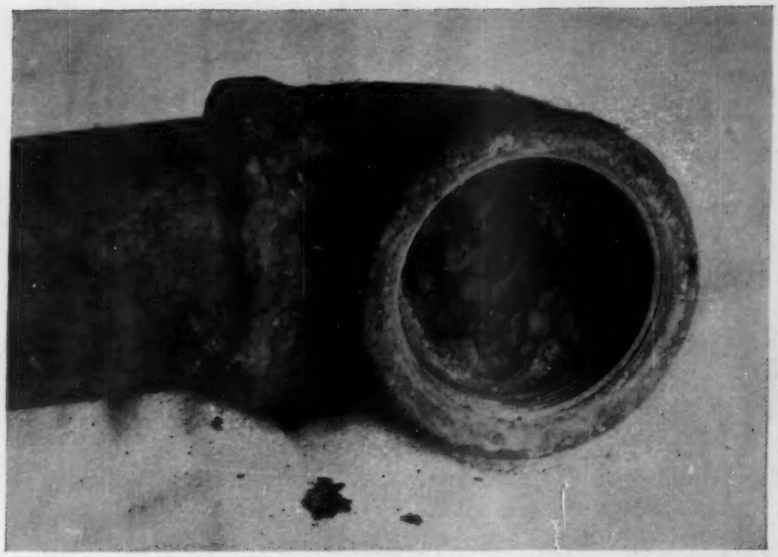


Figure 3—A section of piping from an air conditioning system showing the damaging effects of corrosion.

# CONDITIONING

## Treatment of the Water Circuits

Corrosion is the primary problem encountered in most air conditioning systems. The manufacturers and designers of air conditioning equipment recognize the seriousness of this problem and whenever possible employ materials of construction and design features that will minimize corrosion. They also recognize, however, that a continuous and well-controlled program of chemical treatment for the various water circuits is essential to assure maximum efficiency and life of the equipment.

The treatment of the water used in air conditioning systems does not represent an unusual challenge from the chemical standpoint. The problems of corrosion, scale formation and biological fouling are essentially identical to those encountered in most large industrial cooling water systems, for which effective and economical treatments have been developed and successfully applied. The primary difference exists in the spray water employed in the air washer which serves the dual function of cooling and dehumidifying the air in the summer and heating and humidifying the air in the winter. During the dehumidifying cycle, moisture is condensed from the air and becomes part of the spray water and this water eventually approaches the characteristics of the condensed moisture. During this cycle corrosion is the primary problem. During the humidifying cycle the moisture added to the air comes from evaporation of the spray water and as a result the spray water tends to concentrate and the dissolved salts, particularly those of calcium and magnesium may lead to scale formation. The volume of water in the air washer—particularly when a closed chilled water system is employed—is quite small compared to the large volume of air handled. As a result the characteristics of the water in the washer can change quite rapidly. In addition, the inoculation of the water with air-borne bacteria, dust, lint, and corrosive gases intensify the problem. The true challenge is not the complexity of the chemical treatment problem, but the *application and control* of the treatment to handle the constantly changing conditions. In most cases, the failure of chemical treatment has been the direct result of improper methods of application or inadequate control.

## Application of Treatment

Proportional feed of treatment and continuous blowdown of air conditioning units are mandatory if good results are to be secured. Automatic, trouble-free feeding equipment has been designed to handle the rapidly changing conditions encountered in air conditioning units. The application and control of treatments for prevention of corrosion, scale and biological fouling has been greatly simplified.

---

The Betz approach for treatment and control of air conditioning water problems will assure protection of your investment and make air conditioning a plant facility that pays for itself. For more details on automatic, trouble-free proportioning of water treatment chemicals to air conditioning systems, write for Bulletin 597A.

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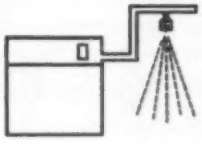
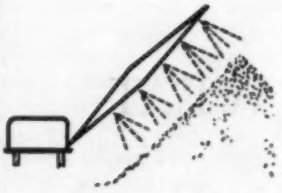


**J-M Chem-Jet**—Systems engineered to control dust at the source in bulk materials handling.

**J-M Scrubbers**—guaranteed 99% efficient in removing dust, fumes, odors.

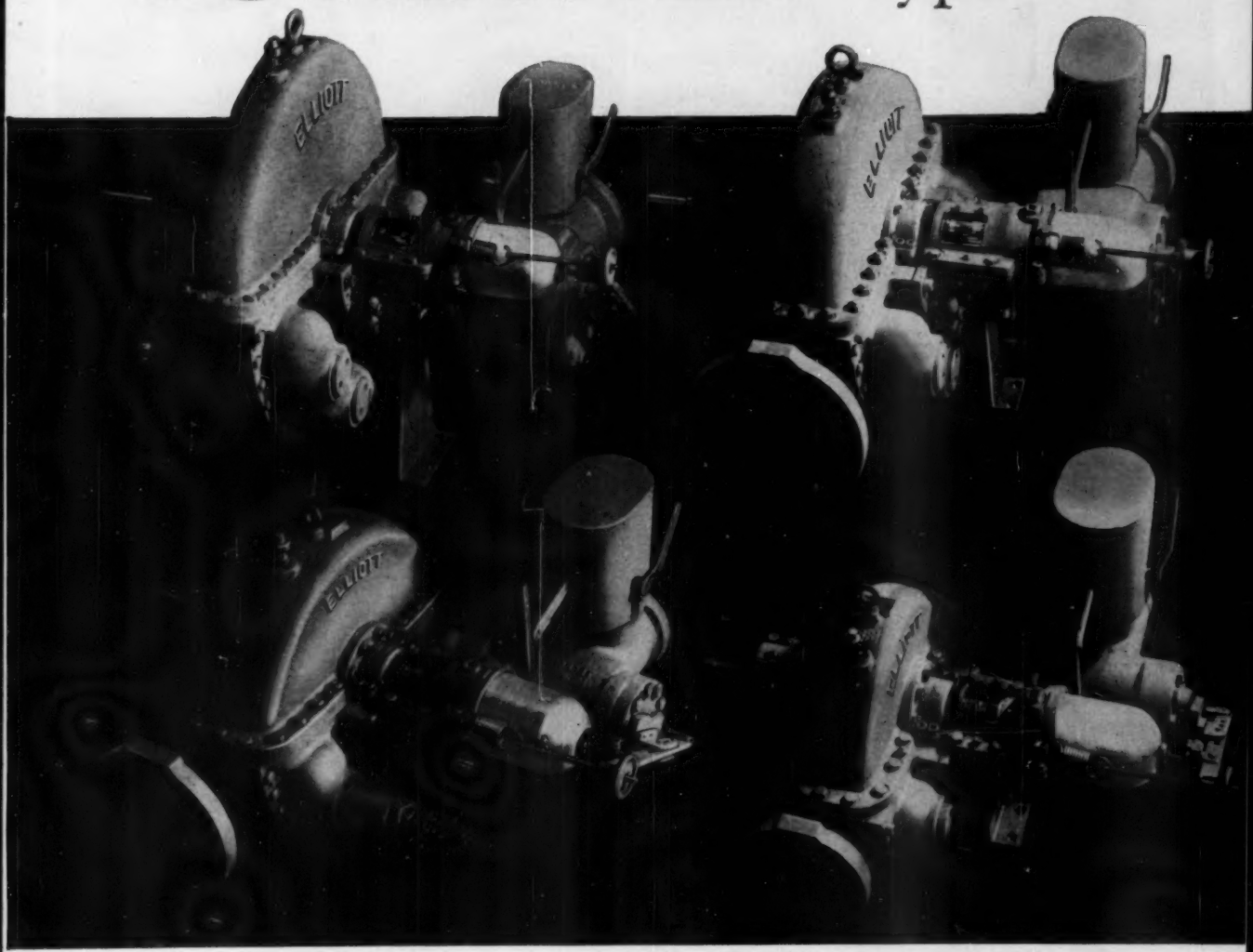
**J-M Verticone**—for dust-free unloading from bins and silos; for the process application of liquids to solids.



**J-M Compound S-P**—prevents costly windage loss of materials stockpiled outdoors.

For more data circle 511 on Post Card

# ELLIOTT mechanical drive TURBINES type YR




## STURDY! WEATHERPROOF! DEPENDABLE!

All-weather protection, standard for Elliott type YR turbines, assures dependable operation under all conditions of heat, cold, moisture, dust and contaminated atmosphere.

The direct-acting speed-governing system is simple and positive, available in several modifications to match speed and pressure requirements. The rugged rotor assembly is dynamically balanced. Bearings and shaft seals are readily accessible for maintenance. Hand valve reduces steam consumption at partial loads.

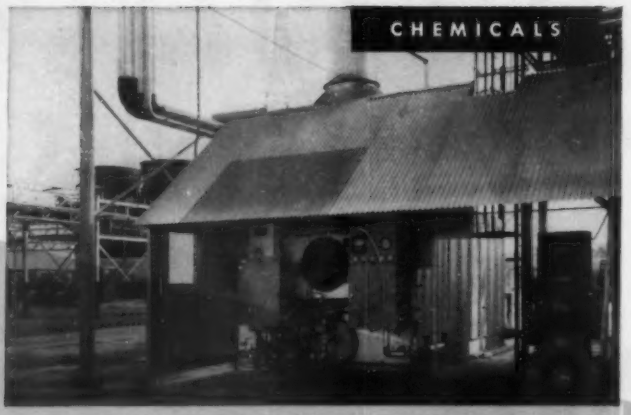
Many other features contribute to the dependable and economical performance of Elliott type YR turbines. Write for complete details to Turbine Division, Elliott Company, Jeannette, Penna.

**ELLIOTT Company**
Jeannette, Pennsylvania

HO-1

For more data circle 512 on Post Card

3 — 60,000 lbs./hr. Erie City Natural Circulation Keystone Package Steam Generators — oil fired — outdoors — a large eastern steel mill.




1 — 30,000 lbs./hr. Erie City Natural Circulation Keystone Package Steam Generator — gas and oil fired — outdoors — Southern Nitrogen Co., Savannah, Ga.

# You'll Find KEYSTONE

## Wherever Engineers Insist on the Very Best

Indoors or outdoors, at home or abroad, wherever you look you will find Erie City Keystones delivering low cost, economical steam. The Keystone combines the best in design features and sound construction procedures to deliver a package water tube steam generator with unsurpassed advantages. These mean savings to you.

**Symmetrical Design** — easy to unload, easy to move.

**Tangent Furnace Tubes** — act as baffle, no heavy refractory tile required.

**Tangent Outer Tubes** — plus steel jacketed insulation keep heat loss to a minimum.

**Welded Inner Seal Casing** — eliminates casing corrosion problems.

If you are presently in the market for a water tube package generator or if future expansion may require a unit of this type, investigate the Keystone. You owe it to yourself to see one in operation before you buy. For detailed catalog information, write for Bulletin SB-6302-G.

### KEYSTONES Known by Companies They Serve

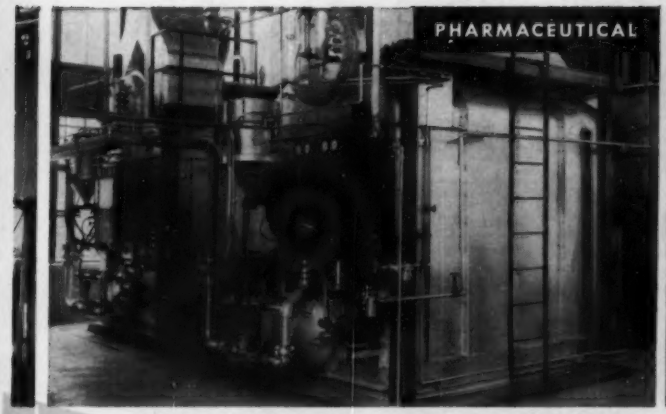
• HERE ARE A FEW:

Amalgamated Sugar Co.
American Cyanamid Co.
Bay Petroleum Corp.
Clark Equipment Co.
Firestone Tire and Rubber Co.
Foote-Burt Co.
Kraft Foods
Gulf Oil Corp.
McDonnell Aircraft Corp.
Miles Laboratories, Inc.
Oregon Pulp and Paper Co.
Pittsburgh Plate Glass Co.
Reynolds Metals Corp.
Sherwin-Williams Co.
Texas Co.
Welch Grape Juice Co.

*You can depend on* ERIE CITY Since 1840 *for sound engineering*

## ERIE CITY IRON WORKS • Erie, Pa.

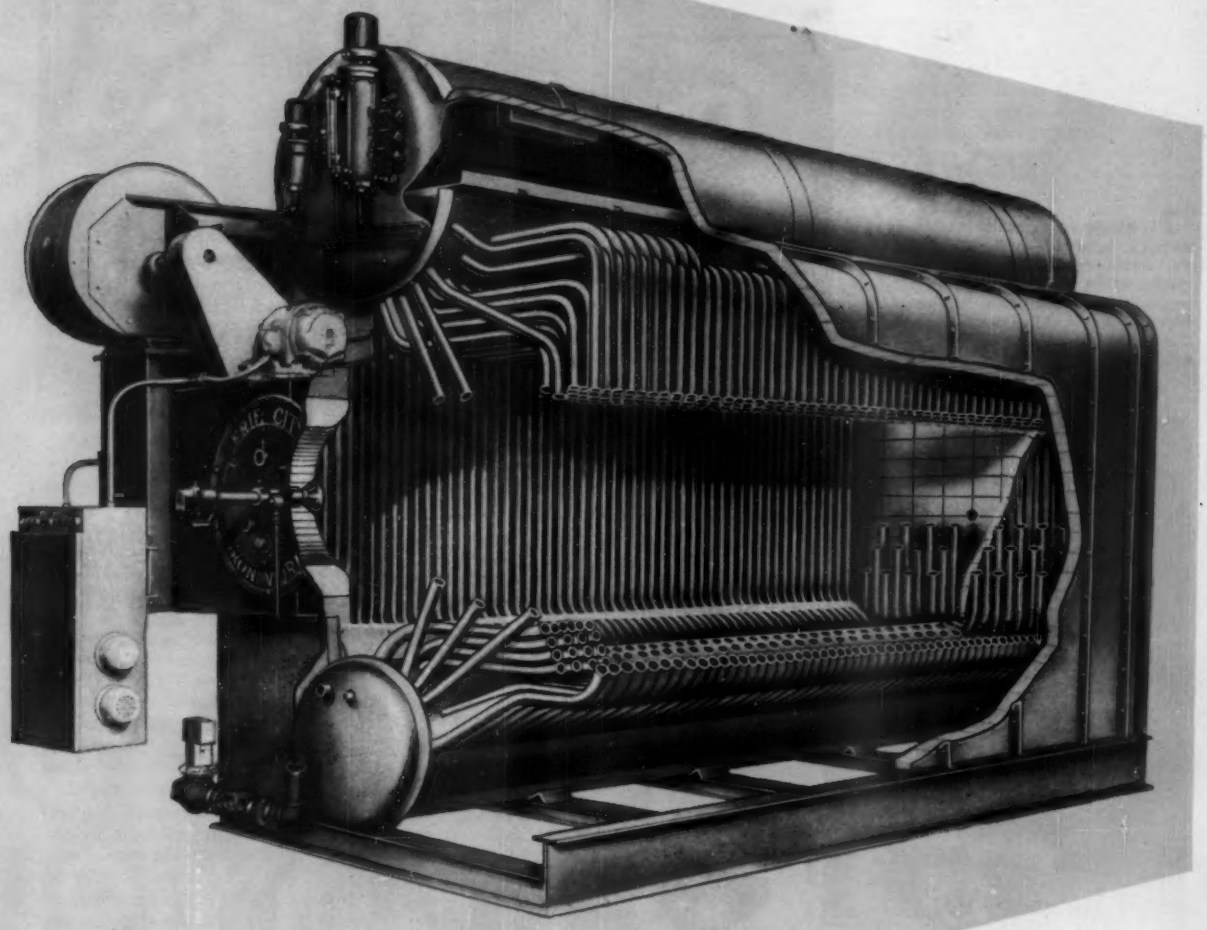
STEAM GENERATORS • • • SUPERHEATERS • • • STOKERS • • • PULVERIZERS
ECONOMIZERS • • • WASTE HEAT BOILERS • • • OIL and GAS BURNERS
AIR PREHEATERS • • • FIRE and WATER TUBE PACKAGE BOILERS




2 — 8500 lbs./hr. Erie City Natural Circulation Keystone Steam Generators — gas and oil fired — Eli Lilly & Co., Greenfield, Ind.

3 — 20,000 lbs./hr. Erie City Natural Circulation Keystone Steam Generators — oil fired — Fabrica Dominicana De Cemento, Ciudad Trujillo, Dominican Republic.

# Steam Generators



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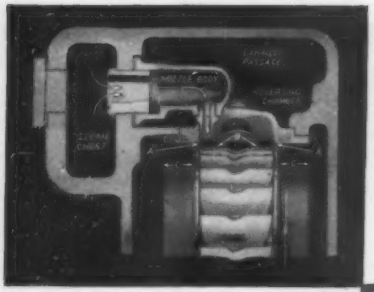
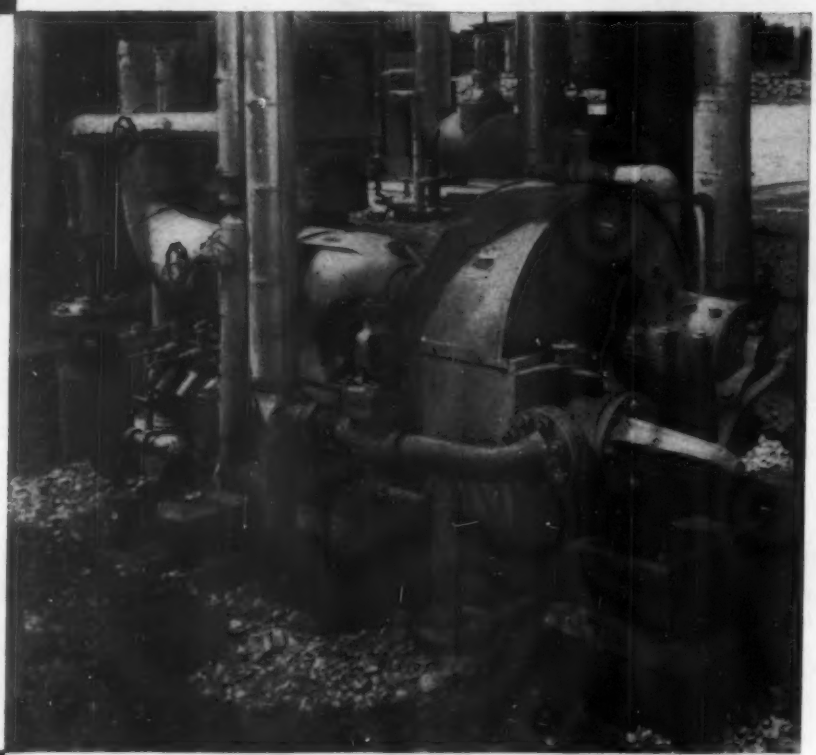


# TWO REASONS WHY

## *this turbine seldom sees down time*



**1** ***Generous wheel clearances:*** AA —rim clearance, B—blade clearance, CC —side clearance. Blades can't foul as they are protected by rims. Rubbing at AA will do no damage. Side clearance is so large (about one inch) that end-play from excessive external thrust cannot damage wheel.

**2** ***Blade wear is of little consequence.*** In a Terry solid-wheel turbine, the steam enters the buckets at right angles to the shaft. As its power-producing action takes place on the curved surfaces at the backs of the buckets, wear does not materially affect horsepower or efficiency.

To prevent costly shutdowns for repairs, Terry builds bonus reliability into each solid-wheel turbine. Two of the ways in which this is accomplished are shown in the diagrams at the left.

Further details of these simple, fool-proof turbines are illustrated and described in bulletin S-116. If you do not already have a copy of this publication, send for one today. No cost or obligation.

**THE TERRY STEAM TURBINE CO.**
**TERRY SQUARE, HARTFORD 1, CONN.**

TT-1217

**TERRY**

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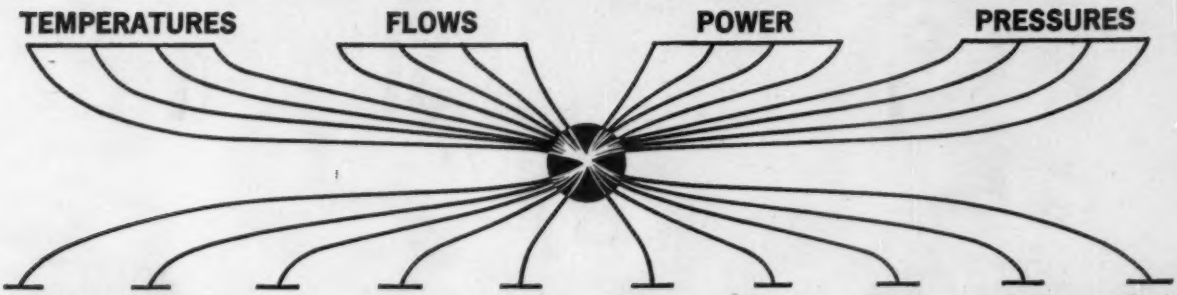
# KYBERNETES SERIES 2000




| Gross Sta. Gen. (KwHr) X 1000 | Net. Sta. Out. (KwHr) X 1000 | Sta. Load (Kw) X 100 | Bus Volt. (V) X 10 | Sta. Heat Rate (Btu/KwHr) X 10 | Turb. Throt. Press. (psig) X 10 | Turb. In. St. Temp. (°F) X 10 | Cond. Circ. W. Temp. (°F) X 0.1 | Feed Water Flow (lb/hr) X 10,000 | Feed Water Press. (psig) X 10 |
|---|---|---|---|---|---|---|---|---|---|
| 225 | 195 | 303 | 416 | 870 | 225 | 105 | 619 | 130 | 250 |
| 225 | 195 | 303 | 416 | 870 | 225 | 105 | 618 | 130 | 250 |
| 224 | 195 | 302 | 416 | 870 | 224 | 104 | 620 | 130 | 250 |
| 225 | 195 | 303 | 416 | 870 | 225 | 105 | 619 | 130 | 250 |

# DATA PROCESSING SYSTEM

**√ MORE FEATURES**
**√ GREATER FLEXIBILITY**
**√ HIGH RELIABILITY**

**Here are the specifications . . . check how much more you get—in Kybernetes**

1. Inputs—May be AC, DC, or Digital. Input range—zero to 10 millivolts minimum full scale; 0 to 1 volt maximum full scale.
2. Input Selection—Relay matrix type—individual hermetically sealed plug-in relays.
3. Remote Selector Switch—The input selector switch may be located remotely.
4. Analog to Digital Conversion—Electronic sweep voltage technique.
5. Linearization—Special linearization functions for all types of thermocouples are available. Linearization is to ±1°F over the full range of the thermocouple type.
6. Read-out and Control Panel—Rack mounted as standard, or remote console mounted. Special functions available as required.
7. Output Devices—Typewriters, adding machine type printers, tape punch, card punch or magnetic tape systems.
8. Programming—Pin board programming is standard for full scale ranging, zero suppression, alarm set points (high and/or low), trend logging and function programming. The latter includes provision for linearization, square root extraction, amplifier gain, number of digits logged, computations, and associated requirements.
9. Alarm Comparison—Alarm comparison is accomplished by the digital comparison of the output of the analog to digital converter against the set point established on the pin board programming system. Alarm protection is in operation 100% of the time.
10. Frequency of Periodic Log Cycles—Adjustable from OFF, 5, 10, 15, 30, and 60 minutes. Continuous or single cycle logging available from the on-demand log pushbuttons.
11. Input Capacity—Expandable from 10 inputs up in multiples of 10.
12. Rate of Scanning—Four points per second for off-normal conditions when no other functions are in operation; 3 to 4 points per second for off-normal scanning when auxiliary operations are in effect. Logging at one point per second as standard; other output devices in accordance with the capacity of the device up to four points per second.
13. Integration Sampling Rate—Each point every 10 seconds.
14. Special Sampling Rates—Higher sampling rates available through parallel operation. Simultaneous real time read-out of any quantity of variables available through individual analog storage devices at the input to the system.
15. Hazardous Locations—The system is designed for operations in Class 1, Division 2, Locations (Group D atmospheric mixtures), as defined in the 1956 National Electric Code, the Standard of the National Board of Fire Underwriters.
16. Power Requirement—120 volts, 50 or 60 cycles, single phase, 600 watts. A Zener diode referenced power supply provides a regulated output to within ±0.01%.
17. Accuracy—Over-all accuracy is ±0.1% of full scale. The following tabulation will be useful in evaluating the stability and accuracy of the Kybernetes data systems.

| | Maximum drift—% | |
|---|---|---|
| | 24 hrs. | 6 mos. |
| Chopper Amplifier | .02 | .16 |
| Sweep Generator | .05 | .07 |
| Comparator | .0016 | .0016 |
| Pulse Generator | .001 | .001 |
| Gaging Function | .001 | .001 |
| Counters in Storage | .000 | .000 |
| Reference Voltages | .01 | .01 |
| Reference Oven (Thermocouples only) | .06 | .06 |

**Write for Kybernetes Bulletin MSP-161 today!**

**HAGAN**
**CHEMICALS & CONTROLS, INC.**
HAGAN CENTER, PITTSBURGH 30, PA.

**HAGAN** DIVISION: CALGON COMPANY—HALL LABORATORIES—BRUNER CORP.

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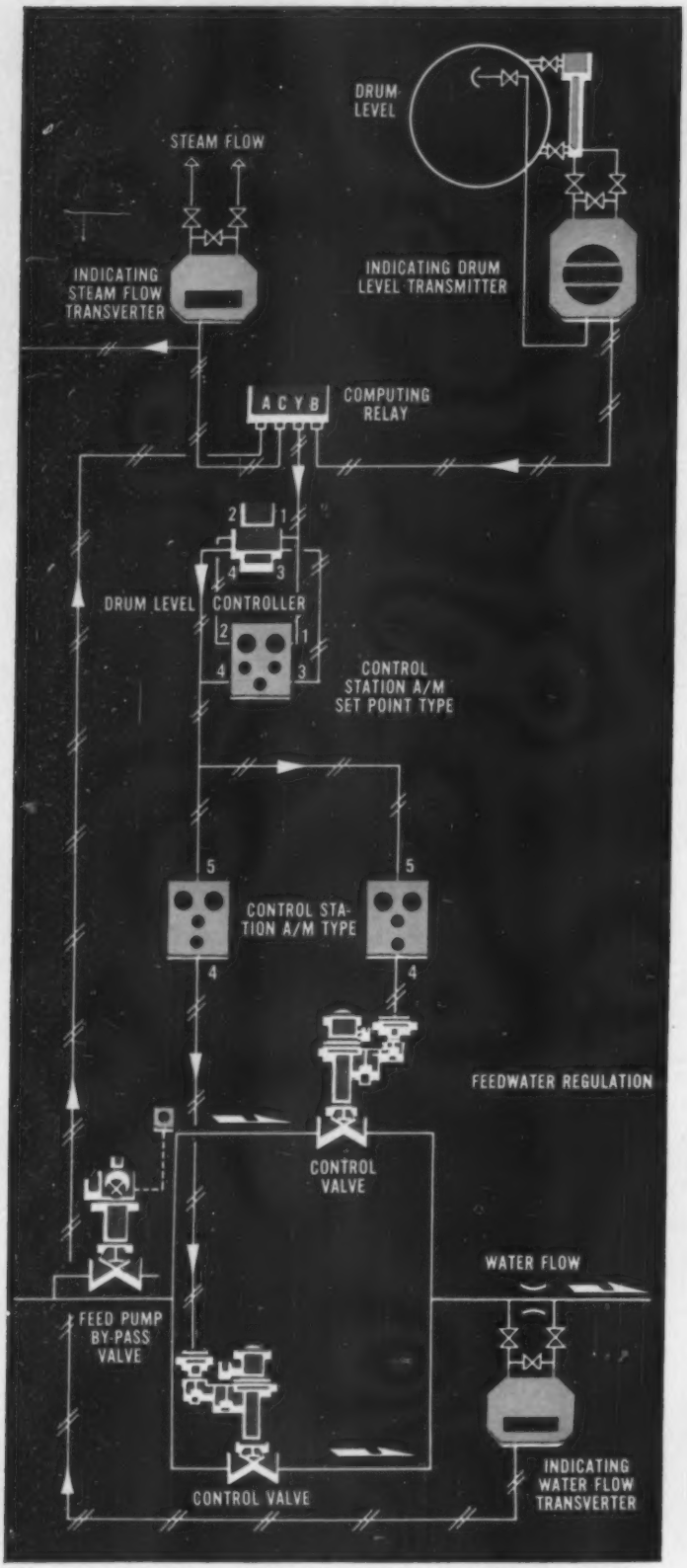
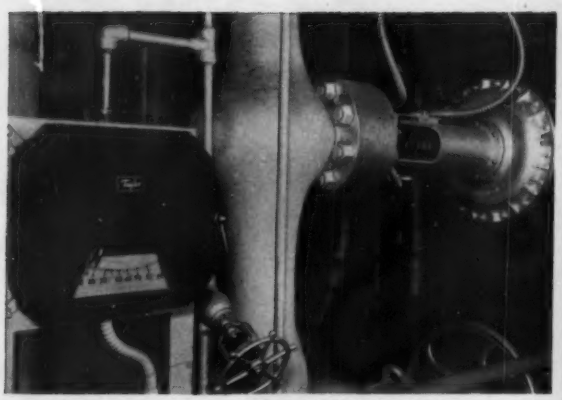
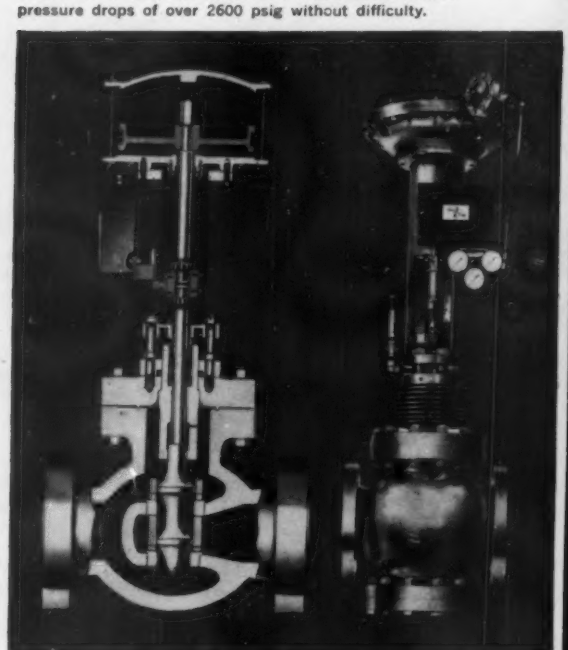



**Three influence feedwater regulation** is just part of a complete Copes-Vulcan boiler control system installed at a pace-setting utility station. Feed to boiler is modulated by steam flow, feedwater flow, and drum water level.



**Copes-Vulcan recirculation control** protects boiler feed pumps. When pump discharge falls below a certain level, a diaphragm-operated by-pass valve opens to assure sufficient flow to prevent overheating of the pump.

**A feedwater and heater by-pass valve** is shown above. Also, a Copes-Vulcan control valve is installed in each of the two main boiler feed lines. These valves handle pressure drops of over 2600 psig without difficulty.



**Versatile control valves** feature simplicity of design. Piston-type CV-P (left) is ideal for high-duty service. Diaphragm-type CV-D (right) is designed for remote control service. All Copes-Vulcan valves are tailored to the job.

# COPES-VULCAN control valves make boiler feedwater systems accurate and trouble-free...

The big load changes of today's boilers put tremendous demands on the accuracy and dependability of feedwater and recirculation systems. Copes-Vulcan systems meet these demands with positive control, positive performance. ■ As long-time specialists in feedwater control, Copes-Vulcan has the experience and design know-how to custom-engineer control valves to rigid specifications. Regardless of high pressure drops, you get close control over full load range, without costly maintenance or replacement. ■ To the dynamic balance of the valves, Copes-Vulcan adds advanced instrumentation. The highly-responsive control system stabilizes water level regardless of changes in load or feed pressure. ■ Bulletin 1038 describes efficient boiler control at a key eastern power station. Write for your copy.
Copes-Vulcan Division, Erie 4, Pennsylvania.

*Copes-Vulcan Division*
**BLAW-KNOX**

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POWELL

HIGH PRESSURE

VALVES

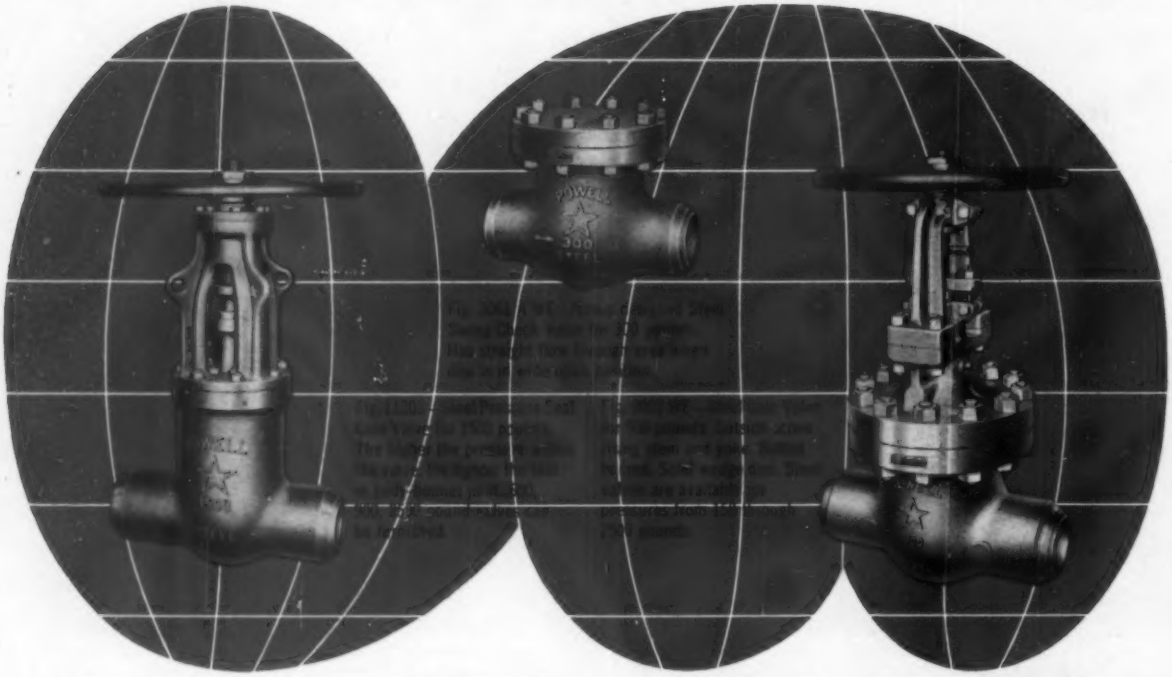
## performance that makes a world of difference

Gate, Non-Return, Globe, Angle "Y", and Check Patterns—All Commercial Sizes—for—150 to 2500 Pounds and Higher; Temperatures—sub zero to 1200 F.

To handle the increasingly higher pressures and temperatures required by modern industry, Powell offers the highest quality steel valves with many exclusive Powell features of superior design and construction.

Many of these Powell Valves are stocked for quick delivery. Contact your city's Powell Valve distributor. Or write directly to us. Our engineers will quickly solve your flow control problems encountered in handling water, oil, gas, air, steam, corrosive fluids.

## Powell . . . world's largest family of valves



THE WM. POWELL COMPANY • DEPENDABLE VALVES SINCE 1846 • CINCINNATI 22, OHIO

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# Current Catalogs

## Electrical Equipment

**101 Induction Motor Selector** — Selection, application and buying information on General Electric Co's Tri-Clad '55 motors, single- and three-phase, from ¾ to 150 hp is given in 14-pp Bulletin GEC-1049. Includes basic information for motor users, application chart for various loads and ambient conditions, tables for dimensions, prices, characteristics and performance data, ordering instructions, modifications, and accessories.

**102 Motor Application Guide** — Sixteen-pp Bulletin 270B outlines characteristics of Century Electric Co. motors of 1/20 to 400 hp and includes up-to-date design information on them. Discusses factors in motor selection and provides illustrated charts covering a wide range of motor-using equipment. Also presented are gearmotors, selective speed drives.

**103 Induction Motor** — In 8-pp Bulletin PB 6000-9 Elliott Co., Div., Carrier Corp., describes construction details and advantages of dripproof induction motors with form-wound stator coils. Illustrates stator frame and core, rotor, ventilation.

**104 Unit Substations**—Detailed information on features, operations and application of selectively-coordinated load center unit substations providing continuous power for a-c distribution systems is presented in 32-pp Bulletin GEA-3592L of General Electric Co. Compares types of load center arrangements and explains how selective coordination of load centers can be provided on any of four basic industrial and commercial building power distribution circuits. Includes photos, line system and schematic diagrams.

**105 Load Centers** — Twin circuit breaker load centers designed to double the circuit capacity of load centers are featured by General Electric Co. in 16-pp Bulletin GEA-7071. Cutaway view showing component features is included, as well as tips on installation, selection data.

**106 Rotary Handle Breakers**—Eight-pp Bulletin 1425 introduces rotary handle circuit breakers of Federal Pacific Electric Co. and discusses their use in switchboards, control centers, panelboards and enclosed circuit breakers. Describes features of the handle mechanism — built-in construction, effortless operation, locking provision etc. Amply illustrated, bulletin also covers application of the 15- through 800-amp breakers.

**107 Industrial Capacitors**—Twelve-pp Booklet B-7642, Westinghouse Electric Corp., answers questions concerning use of capacitors to reduce power costs, increase system capacity, and apply to industry. Subjects include: discussion of power factor, benefits of capacitors, how to select capacitors, and where and how to apply them.

**108 Strongbox Solenoids** — Twelve-pp Bulletin GEA-6215B describes features of General Electric Co.'s industrial strongbox solenoids, including a-c and d-c forms. Describes uses of solenoids, and includes selection information for both push- and pull-type solenoids, with force and current curves shown to aid in selection.

**109 Adjustable Wire Reels** — Illustrated and described in Bulletin 60010-CM3 are adjustable wire reels, available from Line Materials Industries in four mounting assemblies for mounting on truck beds, sides of truck bodies, and pipe rails. Describes features and applications and includes dimensional data.

**110 Equipment for Linemen** — This 32-pp catalog of Charleston Rubber Co. describes high voltage rubber protective equipment for linemen, giving instructions as to its proper care and use. Also lists technical reports available, including a glove care poster, and provides a glove selector chart, ordering instructions and current price list. Among products featured are gloves and sleeves, glove protectors and innerliners; danger flags.

**111 For Insulator Protection** — Form 4-218, of Dow Corning Corp., explains how 5 Compound applied to pole line insulators and electrical equipment bushings protects against excessive leakage, flashovers, and service interruptions in areas where atmospheres are contaminated by salt spray, industrial dust or other air-borne particles. Gives details on function, application, cleaning and durability of compound.

## Lighting, Communication

**112 Miniature Lamp Data Book** — This 24-pp pocket size booklet of Chicago Miniature Lamp Works lists standard miniature lamps available, and sources of supply from which they may be obtained. Specifications of the lamps (nearly 400) are given as well as lamp nomenclature with drawings of styles.

**113 Lamp Annunciator Systems** — Bulletin A-200, 24 pp, presents outstanding features and operational details of modular industrial lamp annunciator systems for supervision, process control, automation systems available from Edwards Co., Inc. Several models of annunciators are covered, also relay cabinets and audible signals. Includes system selector chart, ordering information.

**114 Signaling Equipment**—Air and electric signal systems and specifications of horns, bells, buzzers, chimes and sirens are featured in 88-pp Catalog 160 by Sperti Faraday, Inc. Included are sections on gravity drop and lamp type annunciators and accessory equipment, and charts and diagrams for selection of proper type signal for various background noise levels and work areas.

## Instruments, Controls

**115 Electrical Flow Meters** — Remote-reading, electrical flow meters for liquids and gases at line pressures to 5000 psi are described in 28-pp Publication 59.5 of Republic Flow Meters Co. Principles and engineering features are described, including typical electrical circuits, flow charts, piping and boiler arrangements and piping requirements for orifices, flow nozzles and venturi tubes.

**116 Temperature Controls**—Twelve-pp Bulletin 108 of Assembly Products, Inc., explains operation, circuitry and safety features of three basic types of thermocouple-actuated Simplytrols for kiln, oven, furnace and general industrial processes. Detailed specifications, dimensional diagrams, price and ordering information included.

## Piping, Valves, Fittings

**117 Power, Process Piping** — Piping systems fabricated and erected by Midwest Piping Co., Inc., for power stations and industrial plants are highlighted in 24-pp Bulletin 60B. Includes case-history stories of over 30 plants. Also includes section on company's line of welding fittings and flanges.

**118 To Stop Water Waste** — Bulletin 553-A of Leslie Co. points out ways that proper valve selection and application can reduce "hidden costs" connected with the use of water in industry. Describes how water reducing valves operate and gives information on sizing.

**119 Three-Way Valves** — Twelve-pp Bulletin 91023, Airmatic Valve, Inc., describes in detail company's full capacity series of three-way valves for air, water, gas, chemical or vacuum service. Specifications, ordering information, and dimensions are given, along with information on outstanding features.

**120 Steam Traps** — Forged steel steam traps for steam tracing and instrumentation service are described by Velan Steam Specialties, Inc. in Catalog 200. Diagrams showing operation are included, as well as physical data.

**121 Seamless Welding Fittings** — Twelve-pp Bulletin 60-C describes design features and advantages of seamless-type welding fittings of Midwest Piping Co., Inc. Includes photos of fittings and describes manufacturing operations, dimensional and metallurgical control processes and testing procedures.

**New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the handy Reader Service Cards provided on pages 81 and 82.**

## Mechanical Power Transmission

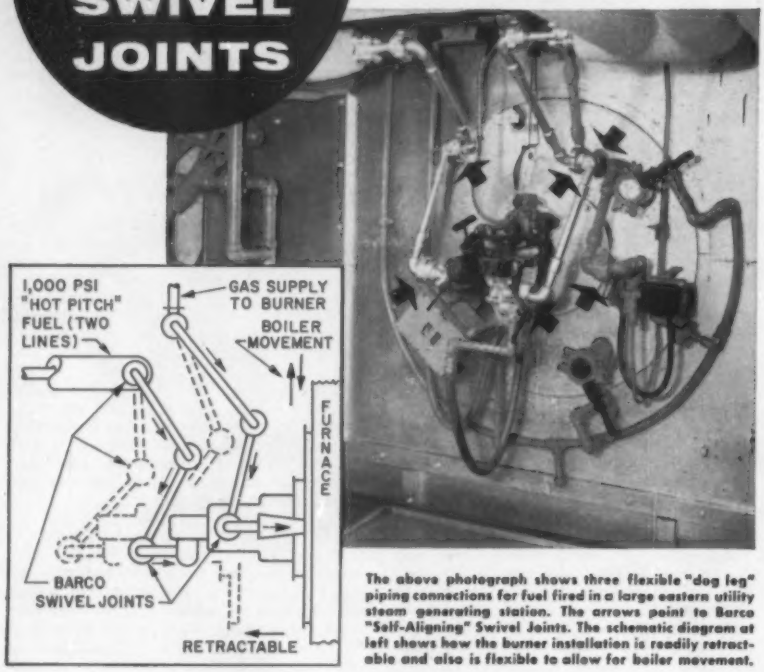
**122 Fluid Drives** — Well illustrated 20-pp Bulletin A-719, on American-Standard's Class 4 line of adjustable speed Gyrol fluid drives, discusses principles of operation and shows typical applications. In describing advantages of the drive, horsepower and inertia starting capacity curves are provided. Components of the unit are illustrated. Selection guide charts are presented for both variable torque and

-Installs

**BARCO** *Self-Aligning* **SWIVEL JOINTS**

# SAFETY for Burners

handling 450° Fuel at 1,000 psi




The above photograph shows three flexible "dog leg" piping connections for fuel fired in a large eastern utility steam generating station. The arrows point to Barco "Self-Aligning" Swivel Joints. The schematic diagram at left shows how the burner installation is readily retractable and also is flexible to allow for boiler movement.

## Power Plant Uses Steel Pipe for "Flexible Connections"

THE idea of using steel pipe, instead of hose, appeals to many engineers—especially where fuel is being handled at high temperature and pressure.

In the boiler plant shown above, heavy pitch, obtained from a nearby oil refinery, is pre-heated to 450°—500°F and pumped at 1,000 psi to the burners of the steam generators. On each burner, two 1" lines feed hot pitch; a third 1½" line (painted gray) handles natural gas for auxiliary firing.

Each line is fitted with three Barco Type S All-Steel Swivel Joints with welded connections. Periodically, all lines are purged with 150 psi steam.

*With a total of 642 Barco joints installed, only one joint has required any maintenance in two years of service.* One of the big advantages of these joints is that they have NO BALL BEARINGS. They don't bake dry at high temperatures. NO LUBRICATION REQUIRED. Another big advantage is that they are *self-aligning;* this eliminates binding and simplifies and speeds up pipe fitting. For detailed information, ASK FOR CATALOG 265D.

PRODUCTS BACKED BY EXPERIENCE
BARCO
FOUNDED 1920

**BARCO MANUFACTURING CO.**
547H Hough Street, Barrington, Illinois

*The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Rotary Joints*

In Canada: The Holden Co., Ltd., Montreal

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constant torque applications. Dimensional data is tabulated and correlated with dimensional drawings.

**123** **Molded V-Belts** — Design features and performance advantages of molded V-belts, fully jacketed and notched, for light duty transmission drives are detailed in Bulletin M220 of Manhattan Rubber Div., Raybestos-Manhattan, Inc. Specifications and drive selection table included.

**124** **For Mounting Bearings**— Selected engineering drawings for mounting Reali-Slim bearings are presented by The Kaydon Engineering Corp. in 28-pp Bulletin S-112R. Low cost, light weight, space saving features are emphasized, specifications and prices for off-the-shelf ball radial type bearings included, as well as engineering drawings of installations.

### Dust, Fume Control

**125** **Dust Control Equipment** — Described by The Ducon Co., Inc. in Bulletin W-8560 is a high energy dust and fume scrubber featuring an adjustable orifice for maintaining peak efficiency under varying conditions. Gives over-all dimensions, pressure drop vs water rate curves, installation sketches and performance results in several installations.

**126** **Simplified Dust Filter** — Bulletin G-30, of The Day Co., gives information on a dust filter with only three moving parts, which filters and recovers dust from airstreams lightly or heavily loaded with fine, coarse, abrasive or non-abrasive dusts. Included are details of method for maintaining porosity of filtering media, operating cost savings and specifications

**127** **Dirt, Dust Control** — Introduced in this bulletin of CRS Industries, Inc., is the Statronic System of dirt and dust control which operates by statically bombarding dirt and dust particles, shattering them to a size below 0.1 micron. Illustrates how it negatively ionizes the shattered particles to eliminate surface smudging to reduce maintenance costs and permit easier breathing.

**128** **Glass-Bag Filters** — Features and advantages of glass-bag filters for cleaning hot, corrosive gases are illustrated and described in 12-pp Bulletin 806. Typical installations are illustrated and methods of cleaning glass fabric bags are covered by Draeco Div., Fuller Co.

### Paints, Coatings

**129** **Protective Coatings** — Bulletin CAC-11-958, 14 pp, describes coal-tar protective coatings of the Plastics and Coal Chemicals Div., Allied Chemical Corp. Primarily moisture barriers and impervious corrosion proofers, these are suitable for use on buried or immersed steel and concrete structures. Booklet lists specifications, resistance properties and typical uses for company's expanded cold-applied cold-tar coatings.

**130** **Fire-Retardant Paints** — Twelve-pp, pocket-size Bulletin 100, The Albi Mfg. Co., Inc. tells how fire-retardant paints reduce potential fire damage. Explains significance of the "safety margin" of extra time at start of a fire, as related to protective action of the paints on both combustible building material and structural metal. Discusses service factors, long-range economy of these paints.

*Engineering Excellence Pays Off In Operating Efficiency*

# 'BUFFALO' CYCLONE COMPRESSOR

## HIGHLY EFFICIENT

Tailor-made to each job, these cyclone compressors provide power savings unobtainable with other designs. Exclusive engineering features such as generous inlet boxes, semi-circular inlet bell and matching wheel flange, deep air foil blades, streamlined scroll and divergent outlet all contribute to high static efficiency and lower noise levels.

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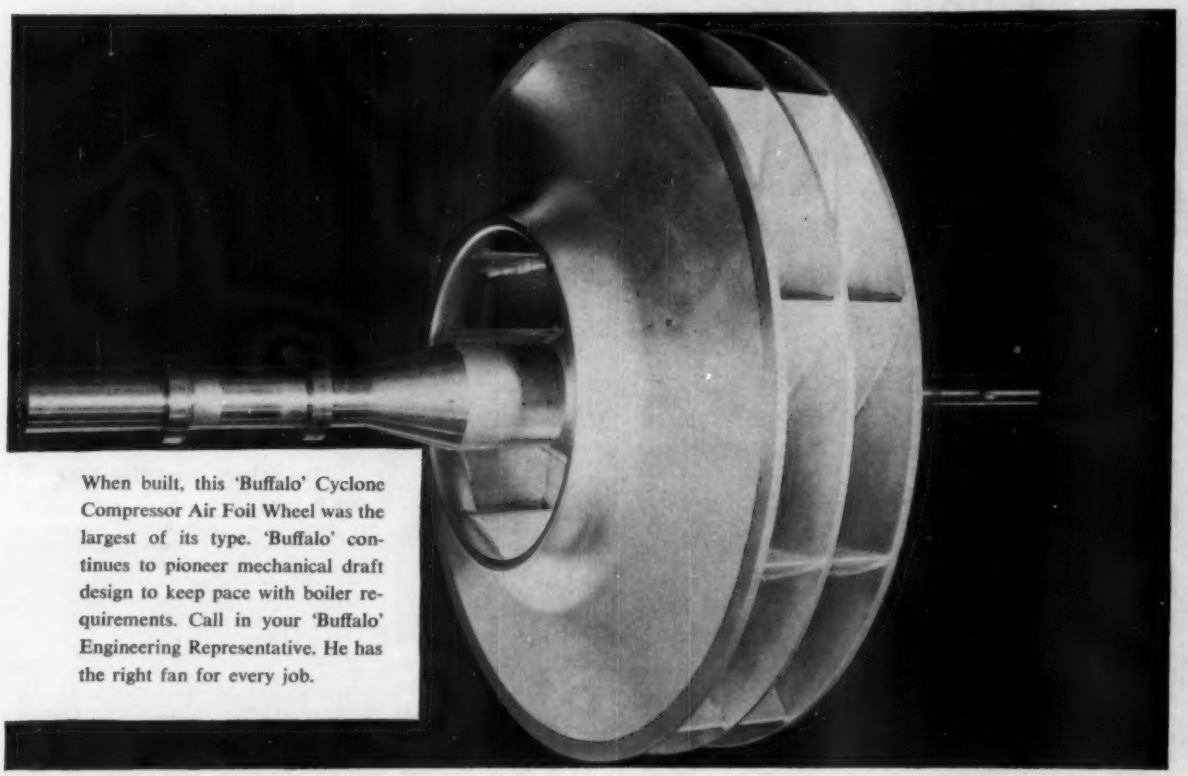

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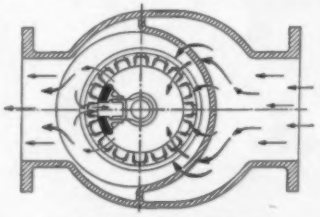

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**131 Adhesives and Coatings** — This product bulletin of Insul-Coustic Corp. describes adhesives, coatings and weatherproofings for the industrial and commercial insulation field. Offers simplified selection method and lists typical applications of the various products covered.

## Pumps, Compressors

**132 Submersible Pumps** — Uses of heavy duty, high-capacity submersible pumps in municipal water systems, water supplies and services, commercial buildings, plants, institutions, schools, etc. are described by Sumo Pumps, Inc. in 8-pp Bulletin B-1300. Outlines ways in which pumps are used for deep well pumping and as in-line boosters. These pumps range to 3300 gpm, and to 125 hp. Details and specifications are also given.

**133 Water-Cooled Compressors** — Bulletin 351, 6 pp, presents 29 advanced features of Class 3-ATC Oilfre compressors of Pennsylvania Pump and Compressor Co. Sizes, capacities and ratings are tabulated. Stresses low maintenance and suitability of these compressors for food processing and other applications in which oil-free compressed air or gas is required.

## Boilers, Burners

**134 High Temp Water Generators** — Described in 16-pp Bulletin 1600 of The International Boiler Works Co. are high temperature water generators, based on principles of forced recirculation which permits temperature differentials to 200 F or more between generator outlet and return water. Boiler diagrams and photos of typical installations, and engineering data section, with flow rate and heat content tables, included.

**135 Gas Burners** — "Fan-Air" gas burners designed to operate with air from a low-speed fan are featured in Bulletin G-100-B. of the Mettler Co., Inc., Div., Eclipse Fuel Engineering Co. Cutaway photos describe combustion design of multiple gas jets which atomize fuel with unrestricted air supply for thorough ignition on mechanical or limited natural draft operations.

## Heating and Cooling

**136 Heavy Duty Coils** — Bulletin B-1518, American-Standard, contains 44 pp of information on heavy duty coils for steam, steam distribution and hot water. Materials and construction details are covered, coil selection discussed with specific example problems and solutions. Layout drawings, tabulated data on dimensions and weights, rating curves, condensate rating information for both saturated and superheated steam, installation recommendations, piping diagrams are included.

**137 Heating-Cooling Coils** — Technical Data Bulletin M-9, Dean Products, Inc. describes features and applications of Panelcoil for heating and cooling all types of tanks, troughs, mixers, and air duct systems. Illustrates installations.

**138 Cooling Tower Economies** — Presented by Hamon, Inc. in this 12-pp bulletin is a discussion of economic comparisons on cooling towers for utilities. Compares natural draft and mechanical draft towers to various approaches and includes detailed cost comparison curves, offers conclusions based on this data.

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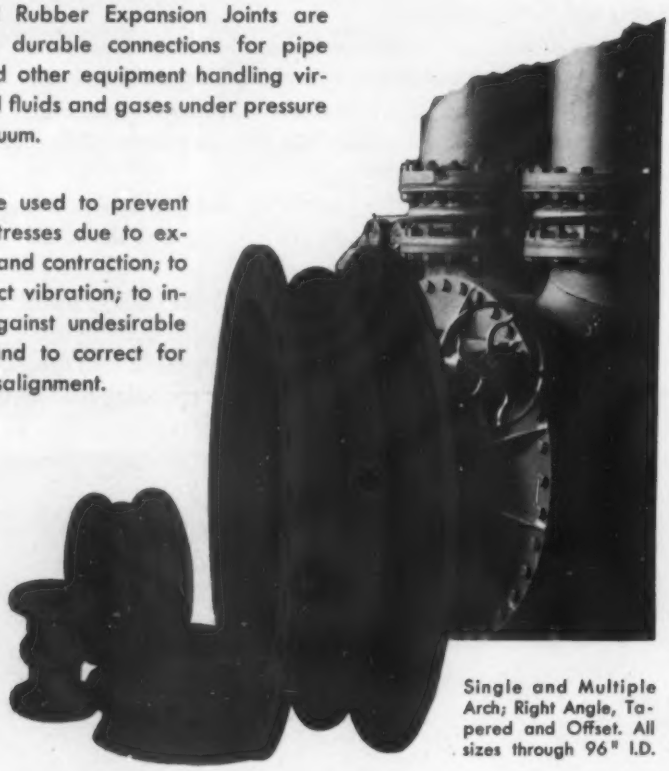

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**139 Double-Flow Aquatower** — Bulletin DFA15-60 describes The Marley Co.'s double-flow Aquatower designed to bridge the gap between standard double-flow Aquatowers and unlimited capacity industrial cooling towers. Specifications and engineering data included.

## Construction and Equipment Installation

**140 Handbook on Waterstops** — In the 24-pp Kwik-Seal Waterstop Technical Manual of Gates Rubber Co. is a wealth of practical information on waterstops and their use. Covers sizes and shapes of the waterstop, comparative data for rubber and plastic types, handling and storage of the material, design data for both "little" and "considerable" movement joints, application data for installation, and splicing methods. Book is illustrated with photos and drawings.

**141 Grouting Guide**—Bulletin E-ld; 16-pp, explains how to avoid shrinkage (cause of grout failure) through use of properly applied non-shrink grout. Describing techniques with Embeco nonshrink grout, this bulletin of The Master Builders Co. illustrates methods of grouting different equipment, mixing and placing of grout, and hot and cold weather grouting. Information on mixes, estimating tables and installations included.

## Metals

**142 High Silicon Iron Alloy** — Properties and applications of Corrosiron — a high silicon iron alloy — in acid resisting drain pipe and fittings by Pacific Foundry Co., Ltd., are detailed in 16-pp Bulletin 97-A. Detailed dimensional and price information included.

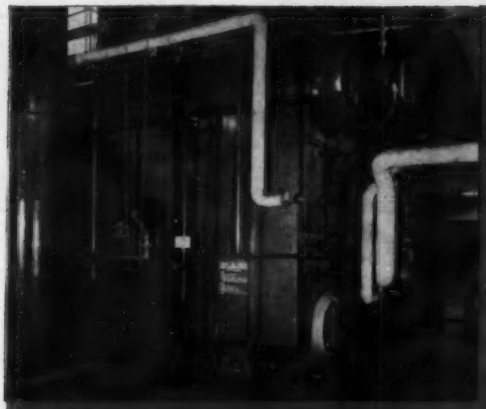
**143 High Alloy Castings** — Compiled by Alloy Castings Institute, this Technical Publications List covers technical papers, articles, reprints and data sheets on stainless and heat resistant castings. They include alloy selection, applications, research (corrosion and high temperature), engineering data, fabrication, foundry practice, metallurgical structure, properties, testing methods, and such topics as purchasing high alloy castings.

**144 Rugged Castings** — Properties and applications of heat and corrosion resistant castings are detailed in this 64-pp booklet of International Nickel Co., Inc. Designed to aid in stainless steel and high-alloy casting selection, it offers comprehensive data on all types of stainless steel and high-alloy heat and corrosion-resistant castings and their applications. Divided into three sections — heat-resistant alloys, corrosion-resistant alloys and fabrication data, it covers such subjects as choice of casting alloy, high-temperature mechanical properties, heat-resistant alloy casting design, corrosive attack, groups of corrosion-resistant alloy castings.

## Other Equipment

**145 Cellular Insulation** — An expanded-cell type tube and pipe insulation designed for use in areas requiring refrigeration and air conditioning service is described by Presstite Div., American-Marietta Co. in this product bulletin. Detailed performance and specification information included.

*more Current Catalogs page 81*



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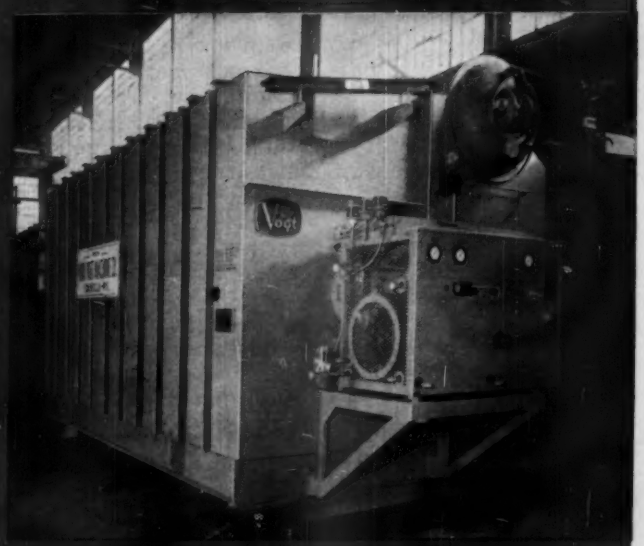

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# ATOMICS

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A POWER ENGINEERING FEATURE FOR UTILITY & MAJOR INDUSTRIAL EXECUTIVES

A. W. Kramer, Editor

A Periodic Report on Atomic Energy Development Throughout the World
Published by Technical Publishing Co.

July 1960

The Great Paper. No single event has had a greater effect on man's understanding of nature than the paper which Albert Einstein wrote in 1905 propounding the theory of relativity. Although the implications of this famous paper were not at first fully understood, it almost immediately offered explanations for a number of baffling difficulties which had plagued scientists for many years. As far back as 1887 Michelson and Morely, in their experiments to measure the drift of the ether past the earth in its course around the sun, found completely negative results—results which obstinately refused to fit into the 19th century conceptions of the general nature of the universe. The difficulties revealed in the negative results of the Michelson-Morely experiment were not isolated difficulties; similar perplexing problems extended throughout a large part of electrical and optical science. In an endeavor to explain some of the paradoxes, certain ingenious hypotheses were advanced—the Fitzgerald-Lorentz hypothesis for example, but these hypotheses were of a makeshift nature, even though they vaguely indicated the direction in which the solution was to be found.

Professor Einstein's paper changed all this. The theory of relativity which he propounded showed that not only the negative result of the Michelson-Morely experiment but many other puzzling matters could be explained if we simply discarded all of the ideas then prevalent as to the fundamental nature and meaning of space and time, and adopt a completely new concept; the concept that space and time were intimately related and that it was meaningless to think of one not in terms of the other.

Gravitation. Perhaps the most startling consequence of Einstein's theory was its explanation of gravitation. Until this time, gravitation was a complete mystery. It could not be explained in any terms involving physical or electrical phenomena. In the years between 1905 and 1915 Einstein published other papers involving further developments of his theory, which among other things showed that gravitation admitted of a simple explanation in terms of space and time. Einstein showed that the force which we had always regarded as a force of attraction towards the center of the earth was in reality a result of a curvature in a four-dimensional space-time continuum. Moreover, Einstein's principle of Equivalence stated that there should be no detectable difference between a uniform gravitational field and acceleration. This means that people completely enclosed in a spaceship with no way of obtaining information from the outside could not tell from any measurement made inside the spaceship whether they were sitting at rest in the gravitational field on the surface of a planet or whether their spaceship was accelerating.

According to the Einstein theory, space, or perhaps more correctly, the space-time continuum, is curved in the vicinity of large masses such as the sun. Consequently, rays of light traveling through space should be bent when they travel close to such bodies, and this provided one of the first means to test the validity of Einstein's theories. Measurements by various astronomical expeditions between 1919 and 1930 provided substantial evidence of the correctness

of this theory. Numerous photographs of stars which appeared near the sun during eclipses of the sun showed an appreciable displacement, as compared with their normal positions in the sky, and these displacements were of the magnitude required by the Einstein theory. The first measurements were somewhat vague, but in subsequent years, as greater refinement in the techniques used became available, experimental corroboration of the theory was more complete.

The Red Shift. Another aspect of the theory of relativity which admits of experimental test is the so-called spectral shift of light towards the red. When light passes out from the gravitational field of a star, it suffers an increase in wavelength; i.e., its color becomes redder. For this reason, the effect is known as the "red shift."

The red shift was first predicted by Einstein in 1907, and the complete theory was derived by him in 1911. Astronomers have been searching for evidence of this red shift in the spectral lines observed in light from the sun and other stars which have very strong gravitational fields for many years. Although many observations show a shift of some sort, the results have not been very clear-cut. All the early observers found some effect of the kind predicted, but its amount was generally substantially less than the predicted amount, varying from almost nil to nearly the full amount expected. The expected shift is extremely small, and the lack of success of the earlier observations was attributed to the fact that the small predicted shift was masked by larger shifts of uncertain amounts arising from other causes. Later observations gave more consistent data, but it has been generally accepted that since there are many effects other than gravitation which can give rise to stellar shifts, the astronomical evidence for a gravitational red shift is ambiguous.

Success at Harwell. During recent years, as a consequence of our greater insight into workings of the internal structure of the nucleus of the atom, efforts have been made to test the red-shift theory in another way. The disintegration of many radioactive isotopes is accompanied by the emission of gamma radiation; that is, X-rays of extremely short wavelength. Scientists reasoned that if the wavelength, or frequency, of such gamma radiation could be measured accurately enough, the method might provide for testing the validity of the red-shift theory.

This is what a team of scientists in the Nuclear Physics Division at the Atomic Energy Research Establishment at Harwell, England, accomplished during the past year. Using gamma rays from a source of radioactive iron, Dr. T. E. Cranshaw and Dr. J. P. Schiffer and their associates, Dr. A. B. Whitehead and Dr. H. J. Hay, have completed two ingenious experiments that appear to confirm two of the basic premises of the Einstein General Theory of Relativity.

In the first of the Harwell experiments, the gravitational effect on the red shift was investigated, using the electromagnetic radiation produced by a radioisotope of iron. These gamma rays have the advantage of having an extremely precise wavelength and can therefore serve as a high precision tool. By allowing the gamma rays later to be absorbed by the same isotope of iron, very small changes in the wavelength of the rays can be detected, and any shift in wavelength predicted by Einstein, minute as it is, would become measurable at heights over 30 ft, approximately, in the earth's gravitational field. Using a water tower at Harwell, the three physicists, Dr. Cranshaw, Dr. Schiffer, and Dr. Whitehead, arranged for gamma rays from radioactive iron to fall through the earth's gravitational field down an evacuated tube for a distance of 40 ft. The rays were then absorbed in iron of the same nuclear structure as the source. By an ingenious experimental arrangement, careful measurements showed an alteration in the wavelength of the gamma rays close to that predicted by Einstein. As expressed in more scientific terms, the measurements showed that the probability of there being no red shift is less than one part in sixty.

In the second experiment, confirmation was sought of Einstein's prediction that there is no way of detecting any difference between a uniform gravitational field and the force of acceleration. For this experiment Dr. H. J.

Hay from New Zealand, who is a member of the Harwell staff and is experienced in the operation of fast rotors, collaborated with the team.

In this experiment the radioactive iron source was placed in the center of a cylindrical rotor with an absorber of iron of the same nuclear structure located at the outside surface. With the rotor spinning at rates up to 30,000 rpm, accelerations were obtained up to 65,000 times as large as the acceleration of gravity on the earth's surface. Variation of the number of gamma rays passing through the absorber at different speeds again enabled the physicists to test Einstein's premise. In this experiment they observed, for the first time in an accelerated system, the effect predicted by Einstein, and thus they conclude that accelerations appear, indeed, to be equivalent to gravitational fields.

Mössbauer's Experiments. The Harwell experiments made use of a recent discovery by a German physicist, Dr. R. L. Mössbauer of the Technische Hochschule in Munich. He found that under certain conditions gamma rays are emitted with an extremely precise energy which, of course, means very precise wavelength. He proved this by allowing gamma rays from an isotope of iridium to be reabsorbed by other iridium nuclei. When he moved the emitting nuclei towards or away from the absorbing ones with velocities of about a fraction of an inch per second, he found that the absorption no longer took place. This, Mr. Mössbauer attributed to a very small shift in the energy of the gamma rays caused by the Doppler effect. The Doppler effect is the effect commonly observed in the change of pitch of a passing train's whistle. By studying the shape of the absorption curve as a function of velocity, he traced out the resonance line and found the effective width to be one part in $10^{11}$ of the energy of the gamma ray. This implied that these gamma rays could be used as a very high precision tool by physicists in various measurements.

$Fe^{57}$. The potential usefulness of this technique as a test of the General Theory of Relativity became apparent to the physicists at Harwell when they discovered that an isotope of iron called $Fe^{57}$ showed an effect similar to the one reported by Mössbauer, but the absorption was fifty times stronger and the line width a hundred times narrower. This was reported in the journal, Physical Review Letters, by Dr. Schiffer and Dr. W. Marshall. The width of the $Fe^{57}$ line was approximately one part in $10^{13}$ while the shift expected from the Einstein theory for a height of 25 ft in the gravitational field of the earth is one part in $10^{15}$, a hundred times smaller.

In the Harwell water experiments, the displacement observed of the resonance line was such as to correspond to $0.95 \pm 0.43$ times the effect predicted by Einstein. This implies that the probability of there being no red shift is less than one part in sixty.

The radioactive source for these experiments was prepared on the University of Birmingham cyclotron by bombarding an iron target for one hundred hours with a beam of deuterons. The source was purified at the Radiochemical Center of the United Kingdom AEC at Amersham.

Scientists in several other laboratories in England and the United States are working on similar experiments independently. The Harwell group hope to repeat their measurements with greatly improved accuracy during coming months in order to give added weight to their conclusions.

Thus, once again the great theory which Albert Einstein propounded finds corroboration in the exact experimental work of modern science. Although the theory of relativity was quite generally accepted by scientists from the beginning, its implications were not immediately understood by everyone. The discrepancies in the early experimental attempts at confirmation resulted in considerable discussion and some skepticism. Even the negative result of the Michelson-Morley experiment, which to a large extent led to the formulation of the Einstein theory, was questioned; and in at least one instance, the experiment was repeated by some investigators in an attempt to disprove the original negative conclusions. This early skepticism had a beneficial effect since it

only served to stimulate interest in the theory and led to continued efforts to prove or disprove Einstein's conclusions.

Gravity and Acceleration. The concept that the force of gravitation cannot be distinguished from acceleration is particularly difficult to understand, and the statement that gravitation is in reality the result of a curvature in a four-dimensional space-time continuum, did not clarify the situation.

An object falling to the ground is acted upon not only by what we call gravity but also by centrifugal force arising from the earth's rotation. Actually, the path of the falling object is the resultant of these two effects. It is only because the earth's rotation is comparatively slow that the conception of an attraction towards the center of the earth gives a reasonably logical explanation of the fall of an object. If the earth's speed of rotation were 17 times its actual rate, falling objects would always fall parallel to the earth's axis, and in the northern hemisphere people might attribute this to a force of repulsion from the north star. On the other hand, if the rotational speed of the earth was many times greater than this, falling objects would always fall perpendicularly away from the earth's axis, and this might be explained on the basis of a repulsive force from the earth's axis. It is therefore easy to confuse the acceleration arising from the earth's rotation with gravitational attraction. Aviators probably know this better than anybody else since it is inherently impossible to build an instrument to indicate the vertical direction in an airplane. An acceleration in an airplane produces on any instrument effects which are indistinguishable from those of gravity.

It may not be clear how acceleration is involved with the steady rotation of the earth. This is because the term acceleration is used here in its broadest sense. Acceleration is the consequence not only of a change in the velocity of an object but also from a change in the direction of motion. In the case of an object on earth, the acceleration or the curvature of path which brings about the effect of gravitation cannot be an acceleration or curvature in ordinary three-dimensional space. Before an object starts to fall, it is neither accelerating nor is there any curvature in the objective sense, yet the object starts to fall as soon as it is released. Our three-dimensional space is subjective; it is different for different observers, dependent upon their frame of reference. Einstein, therefore, was led to the idea that gravitation arose from curvature in the four-dimensional space or continuum, in which time formed the fourth dimension. This continuum is objective, and if the path of a falling object can also be made objective, the resulting gravitation will conform to the relativity principle propounded by Einstein. Einstein found that the actual type and degree of curvature of the space-time continuum were uniquely fixed in terms of the masses of the gravitating bodies. Thus, knowing the mass of the sun, Einstein found himself able to calculate exactly the motion of certain planets around the sun, and by this means he was able to explain the discrepancy in the orbit of the planet Mercury, which had long baffled astronomers. Now, as a result of the research at Harwell, another method of proof of the theory of relativity has been obtained.

Andrew W. Kramer

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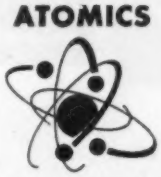

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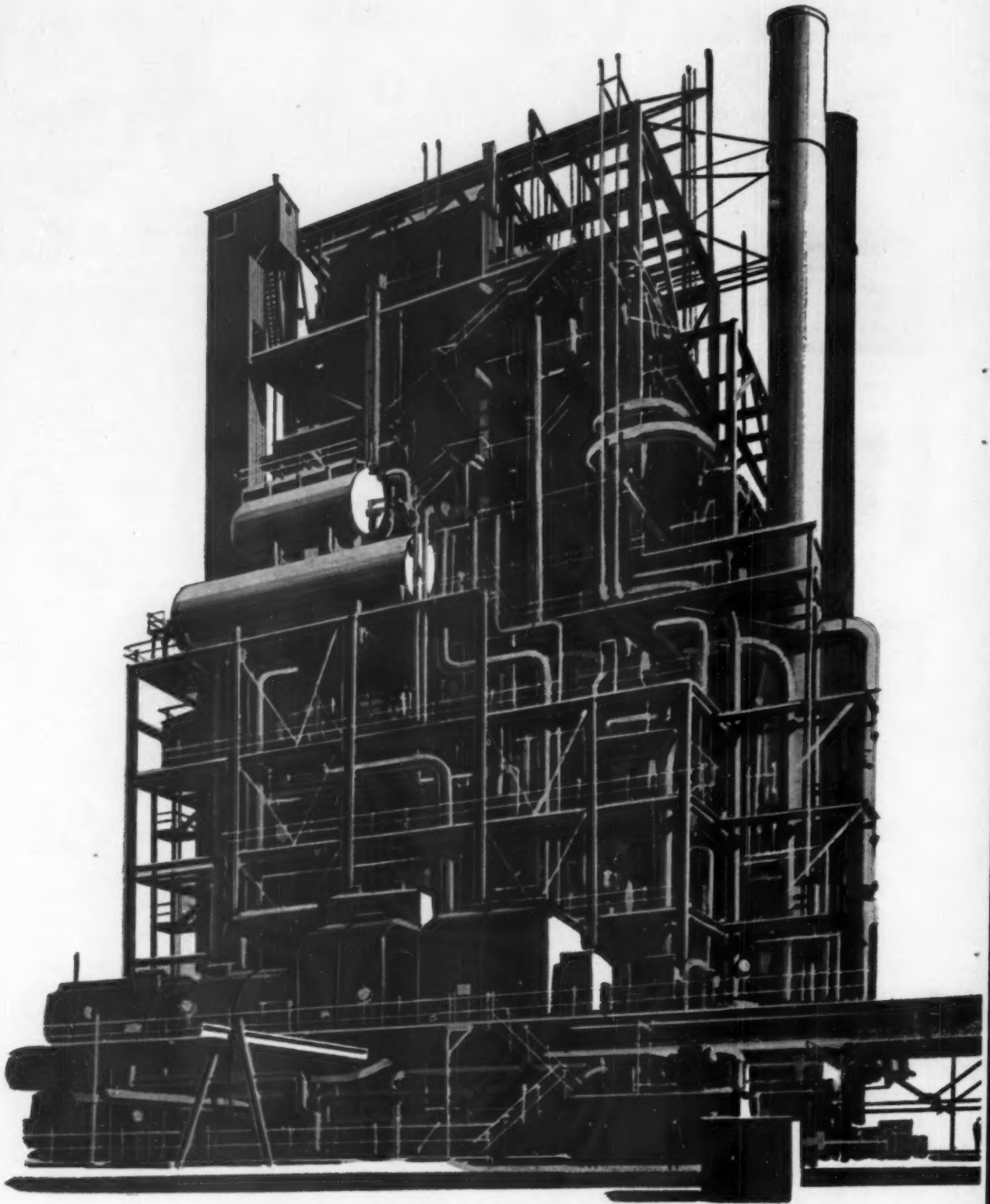

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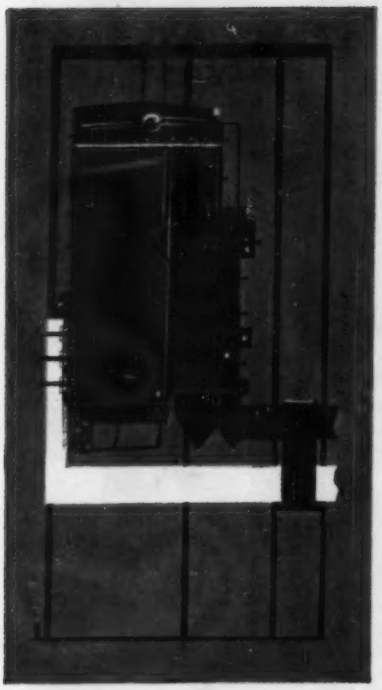

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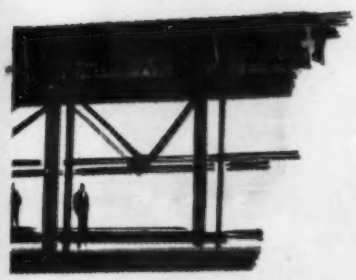

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PUBLISHED FOR MORE THAN 60 YEARS — EXCLUSIVELY FOR POWER ENGINEERS — IN EVERY FIELD WHERE POWER IS USED

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AS YOU TURN the editorial pages, a new look begins to emerge. In adopting this new look, our object has been to make POWER ENGINEERING as modern in design and layout as it is in editorial content; to save readers' time; to make the technical material look more attractive; to help the reader get into the articles quicker.

When questionnaired, an overwhelming majority of readers wanted us to keep the cover substantially as it has appeared for the past few years, with the complete contents on it for quick reference without leafing all through the magazine.

Most readers said our editorial text is easy to read, and that no change should be made in style or size of body type, also that the editorial articles should be kept grouped into one section.

Accordingly, in the following pages, you will see new headline and page layout styles, larger illustrations, color for both technical emphasis and attraction. Technical material can look good and be good, too.

Our Catalog Library will be issued as a supplement periodically in the future, rather than in its previous monthly form in the magazine. New equipment data, however, and Engineers' Preview pages remain the same, but What They Tell Us is now combined with Tracers. Handbook pages also are rearranged.

Finally, the content of POWER ENGINEERING remains the same: specific technical data to help power engineers everywhere with their on-the-job problems. We have tried only to improve the appearance of our pages. Let us know what you think of them.

THE EDITORS

CONSERVING WATER BY RECIRCULATION

# KAISER STEEL PLANT MAKES A LITTLE WATER GO A LONG WAY

## THIS BIG PLANT MAKES STEEL WITH LESS THAN 1600 GALLONS OF WATER PER TON OF STEEL. H. I. RIEGEL, UTILITIES SUPT., TELLS HOW IT'S DONE

RAW WATER for the Fontana, California, plant of Kaiser Steel Corp. is purchased from a local water company and supplemented from two deep wells on the property. This water is stored in a 4,500,000-gallon reservoir. The reservoir supplies the water treatment plant where reduction of solids is accomplished by cold lime treatment.

Due to the location of the plant in an area where soils have a tendency to be alkaline, every effort is made to keep the use of sodium compounds to a minimum. Practically all water softening at this point is the result of reduction of solids. All make-up water used in the plant passes through the water treatment plant. Industrial water make-up receives the same treatment as the domestic water, except that the industrial water is in an open reservoir and the domestic water is stored in a covered reservoir.

Water from the domestic reservoir is pumped into the domestic system by three 2000-gpm electrically-driven pumps. The domestic system supplies water for powerhouse use, sanitary requirements, lawn and shrubbery requirements, fire protection, and some minor industrial use. Water for the

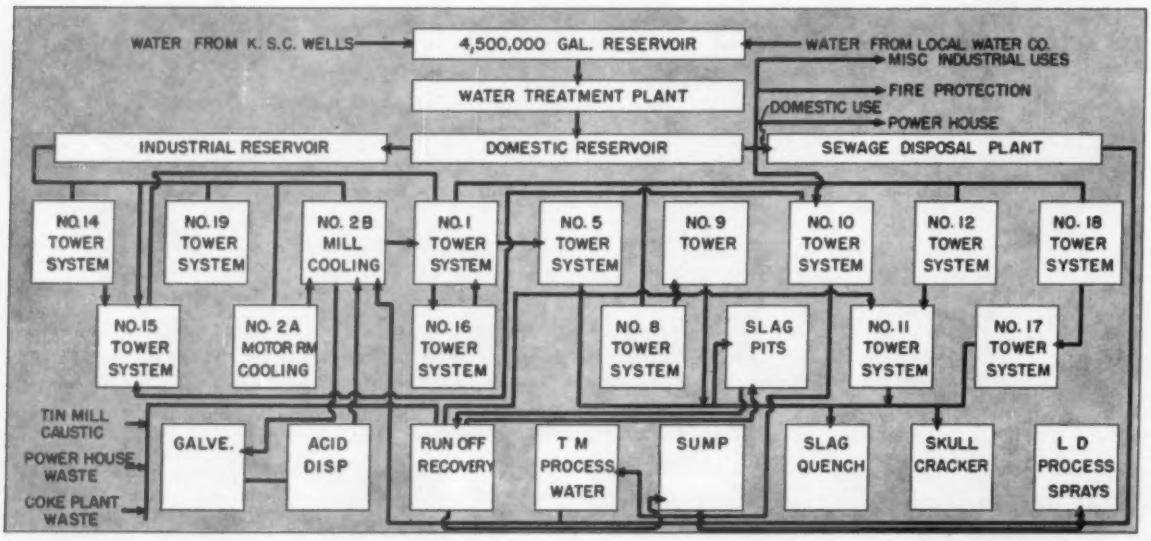


Fig. 1. Schematic layout of water system at Fontana Works. The principle is a number of systems in series and paralleled

Fig. 2. View of four blast furnaces (left), open hearth facilities on right, left center draft cooling towers. In center are concrete and steel elevated towers for pressure control. Plant now has capacity of three million tons a year

boilers receives further treatment at the powerhouse, where zeolite softeners are used.

The industrial water system consists of a number of individual industrial water systems in series and paralleled. General concept is that the water passes through a number of systems in series with the blowdown of one system becoming the supply of the following system.

The systems are in sequence in order of quality requirements, the first system having the highest quality requirement and the last system, the poorest. Last system supplies water for such needs as cooling of slag, and spraying of some raw materials for dust arresting. In the slag cooling process, the water is evaporated, and the solids become combined with the slag mass.

First system in order of water use at present is the motor room and reheating furnace system designated as "2-A." This system has induced-draft cooling towers which deliver cooled water to cold water pumps which deliver water at 50- to 60-lb gage pressure to the motor room coolers. This water then passes through reheating furnaces to a pump sump where the cycle starts over.

If this system were a completely closed system supplied with make-up water to compensate for the water evaporated, the resultant concentration of solids would soon render the system ineffectual because of build-up in coolers and pipe lines. To prevent such an occurrence, water is drawn from this system into the succeeding system to carry away concentrated solids.

In practice, it has generally been found that the requirements of make-up water for the succeeding system is greater than the volume requirements to maintain solids below objectionable limits in the previous system.

Second system in the sequence is designated as "2-B." This system supplies water to the mills for bearing cooling, roll cooling, and some scale flushing. Water in this system picks up heat, oil, grease and some scale from the mills. The facilities and problems are somewhat more involved. The water passes over a natu-

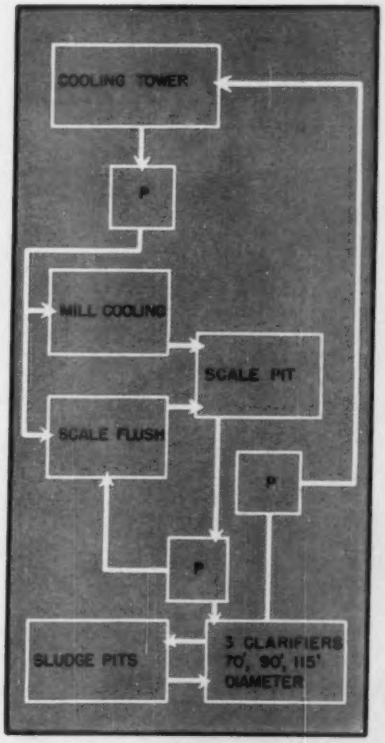


Fig. 3. Plan of the 2-B system is typical

ral-draft cooling tower and through traveling screens to a pump sump where pumps deliver the water to the mills for use. The mill water passes through a scale pit and then to a pump pit where part of the water is pumped to a scale-flushing system.

Remainder is pumped to clarifiers where the fine scale and other solids are settled out and the oil skimmed off. Effluent of these clarifiers is pumped over the cooling towers to start another cycle.

This system has received some attention since its original installation. It was found that scale pits at the mills must be of sufficient size and design to settle the finer material even with surges in the system caused by mills starting and stopping as well as pumps kicking on and off. Chemical treatment in the clarifier was abandoned shortly after start-up because of surges lifting not only suspended material over the top but the chemical additions as well. The clarifiers, as now used, supply a satisfactory water for all uses except descaling pumps, where it was found necessary to install automatic strainers with fine mesh.

### Third System

Third system in the industrial water system is the so-called No. 1 system, which supplies cooling water for the open hearth furnaces, the coke plant, and No. 1 blast furnace. This system receives its make-up water from No. 2-B system. This system supplies and cools water but does not condition the water. It consists of both natural-draft and induced-draft cooling towers with necessary pumps and elevated towers for pressure control. It also has a supplementary cooling tower and pumping station at the coke plant.

With increased production and added facilities installed in the coke plant area, it was found desirable and economically feasible to install the added facilities at the coke plant rather than at the site of No. 1 tower. This permitted the by-products facilities to get lower temperature water not required by other facilities on the No. 1 system and still retain the solids stability of No. 1 tower system.

After No. 1 tower, we have a more involved combination of paralleled and series systems. In order to keep confusion and misunderstanding to a minimum, the Nos. 8 and 9 systems will be used as the example. No. 8 tower system supplies the cooling water for No. 2 blast furnace cooling. It receives its make-up water from No. 1 tower system and consists of induced-draft cooling towers and the necessary complement of pumps. It can be considered part of the No. 1 tower system in that they are interconnected on the high pressure side so as to use the elevated towers installed at No. 1 for pressure control.

The gas washing system designated as No. 9 system receives its make-up from No. 8 system. Water is pumped to the electrostatic precipitators and top ring of the gas washer at about 40 lb pressure. The precipitators drain into a pump sump where the water is pumped at 110- to 120-lb pressure into the bottom ring of the gas washer. Gas washer water is drained into a clarifier or thickener. Clarifier effluent discharges into a pump sump, where it is pumped over an induced-draft cooling tower. The cooled water is pumped back into the washer and precipitators for reuse.

### Other Innovations

This system has also received considerable attention since its original installation. Originally, the waters were treated with lime and coagulating agents, and it was found that deposition in the system was excessive, causing lines and nozzles to plug. Later, it was found that the use of lime could be eliminated, and presently only trace amounts of coagulating agents are used. It was also found that lines could be cleaned by bubbling stove flue gas into the water. This would remove lime deposits effectively by lowering the pH of the system. This operation is on a periodic basis depending on need.

Another innovation in this system has been the introduction of air into the clarifier influent water to remove free $CO_2$ carried by the water from the gas washing system. There appears to be better reduction of solids in solution. This is partially evidenced by reduced build-up on the cooling tower members.

Slag from our blast furnaces is run into slag pits where it is allowed to cool before being removed by shovels to railroad cars. To aid the cooling, water is sprayed on the slag. This water is supplied by No. 9 tower and such sources as boiler blowdown, alkali waste from the tin mill, coke plant waste, and other sources where the waters are of such quality as to impair the usefulness of the receiving waters into which they may go.

There are several auxiliary operations which have a marked bearing on the conservation program. The sewage disposal plant which receives the waters from the sanitary facilities, and to a minor degree some industrial waste, recovers waters for use in the industrial water system. This water is delivered to 2-B system and has caused no known trouble.

The waste acid from the plant is delivered to an acid disposal plant where lime neutralization is used. Effort is made to confine the uses of the recovered water to the pickling operations because of the high solubility of the calcium sulphate. Care must be exercised not to introduce other waters into the waste acid system because of high equipment cost and the higher volume of waters with soluble calcium sulphate. The treatment of waste acid with lime has the disadvantage of producing large volumes of sludge with relatively higher costs of operation.

The water received by our plant, plus the water pumped from our deep wells, supplies the need of our plant. This requirement has varied between 1400 to 1600 gallons per ton of steel produced. It has been estimated that if all power were generated to supply the plant requirement, the plant water requirement for present capacity would be increased by approximately 320 gallons per ton of steel produced.

However, if the plant were located in an area where rainfall takes care of vegetation need, the water for lawns, shrubbery, etc, would be reduced by approximately 70 gpm. These adjustments would put figures of other steel plants on a comparative basis. The adjusted use would then be about 1650 to 1850 per ton of steel.

The Fontana plant has recently completed its expansion program which increased the steel-producing capacity from about 1,500,000 ton per year to nearly 3,000,000 ton.

### New Facilities

Included in the new facilities are steel-producing furnaces which liberate large volumes of hot and dirty gas which have to be cleaned. In order to condition the gases for cleaning, it was necessary to reduce the temperature, and this was accomplished by the introduction of poor quality water into the gas stream. The cooled gases are then passed through dry-type gas cleaning facilities. It has been found that the use of this poor quality water for this purpose rather than introducing it into the general system has aided in the over-all general system quality.

If water quality is maintained in such a state that it can be reused over and over again with the major loss being evaporation, the problem of water pollution control is greatly reduced. The plant effluent is collected in ponds near the plant. Quality of the effluent must be maintained to prevent possible deterioration of the underground water beyond reasonable limits. THE END

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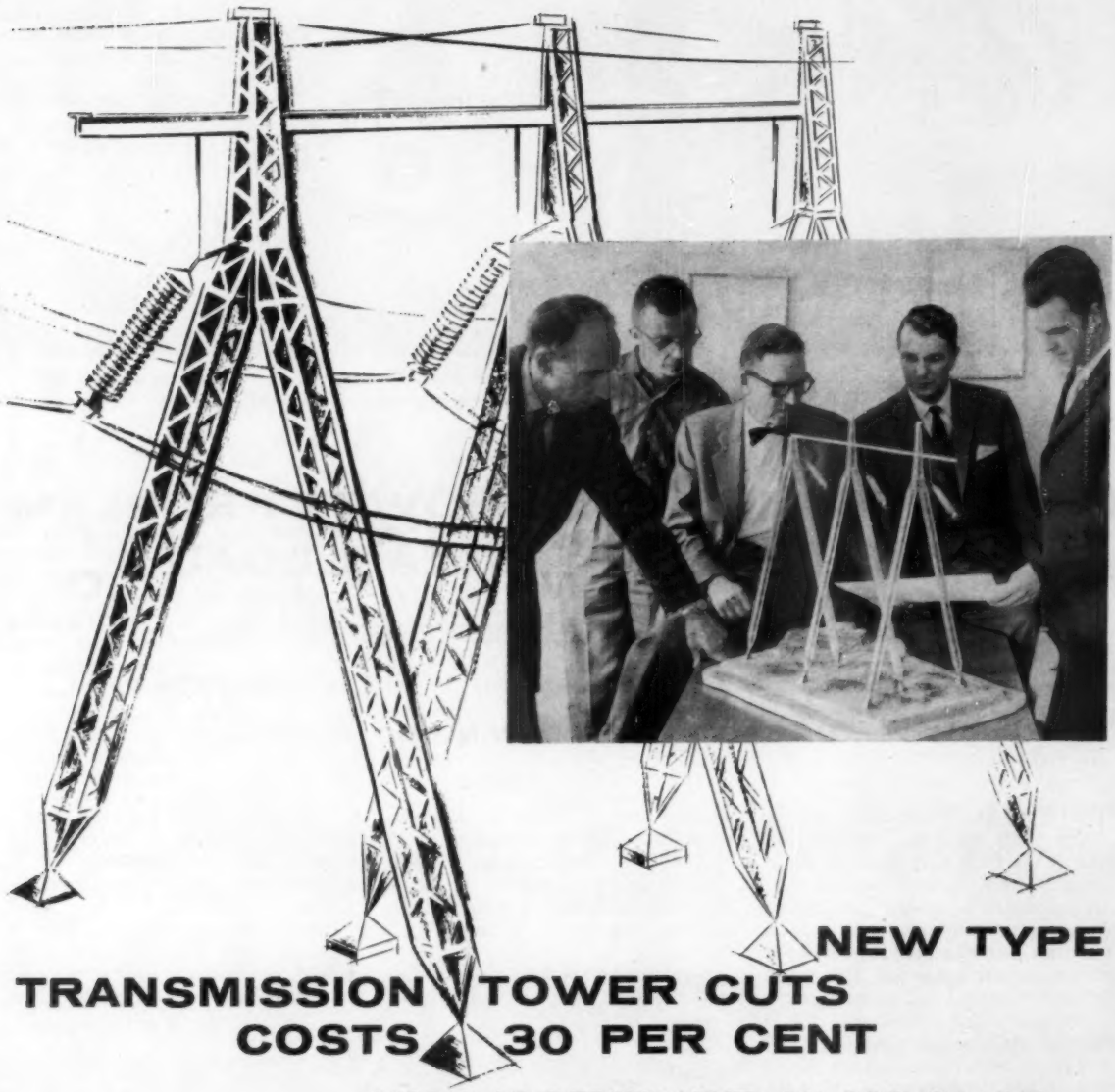
**This article is based on a presentation made before the American Iron and Steel Institute**



# NEW TYPE TRANSMISSION TOWER CUTS COSTS 30 PER CENT

## MODULAR DESIGN USED ON 380-KV LINE

BY UTILIZING a new, lighter type of power line tower for the 1000-km (620-mile) long 380-kv transmission lines Messaure-Hjalta and Kilforsen-Orebro, now under construction, the Swedish State Power Board estimates that a savings of $3,800,000 will be realized through reduced construction costs.

This novel type of tower, which permits construction costs to be cut by over 30 per cent, was designed by the Board's construction-engineering team headed by Lars Berg. Four years of planning preceded the development.

To date, some 50 pairs of towers of the new design have been erected between the recently inaugurated Stornorrfors Power Plant and the Harrsele Distribution Center.

Experience has demonstrated that mounting time can be decreased by using the new towers. Moreover, the light weight of the tower elements simplifies transportation and permits both tower legs to be raised simultaneously, whereas the earlier, heavier type of tower leg had to be raised one at a time.

### Design of Tower Legs

Previously used wire carrier for high-power lines, which required 4400 lb of soil-bound steel foundation, consisted of two portal tower legs; base of the legs was considerably wider than the top. The two legs had to account for stability as well as for carrying the weight of the cables.

New tower legs are slender and, regardless of height, are of a uniform thickness. Stability is attained by means of four truss wires running from the cross arm to the ground. Outer loads of the cross arms cause pressure on the pole legs and tension on the stays. Maximum pressure allowed on each stay is 25 tons, and 75 tons on one leg.

Foundation is relatively small. Only 1800 lb of steel is needed, and the ground shaft volume is reduced. Standardized design of the diagonal bars of the new type of legs has resulted in more economical quantity production. THE END

Power Engineering

# DIESEL SOLVES PEAK POWER PROBLEM FOR BREWERY STEAM LOAD

## OSCAR VANARSDALE, CHIEF ENGINEER, EXPLAINS HOW DIESEL GENERATOR HAS IMPROVED OPERATION OF FALLS CITY BREWING CO. PLANT

THIS 600-kw White diesel engine-generator set was installed last year at the Falls City Brewing Co in Louisville, Ky, to run in parallel with the company's steam generating system during 100 hot summer days. The unit provides standby power at all times, and evens out the swings between electrical and process steam.

The machine is rated at 855 bhp at 900 rpm; its four-cycle, eight-cylinder engine is supercharged to a brake mean effective pressure of 157.8 psi. Mounted on a structural steel subbase, the engine is directly connected to an Elliott 600-kw generator.

Prior to this installation, power at the Falls City plant had been supplied solely by three big steam-generators—two fired by coal and one by natural gas—plus a 125-kva outside power line for overload.

The boilers, although they took up to four hours to start producing, had a total capacity of 140,000 pounds of steam per hour (about 1700 hp). These boilers are the power source for two Elliott turbines, which are actuated by 400 pounds of superheated (600 F) steam to operate two 1000-kw Elliott generators producing 400 volts of alternating current. They are also the source of all process steam.

Steam has many uses in beer processing, chiefly in the cleaning operations of bottles, vats, and other equipment. For sanitary purposes, steam must be kept at a minimum of 366 F, since it must sterilize equipment as well as clean it.

When the demand for beer is greatest, more process steam is required, and less can be diverted to the turbine generators for power. Into

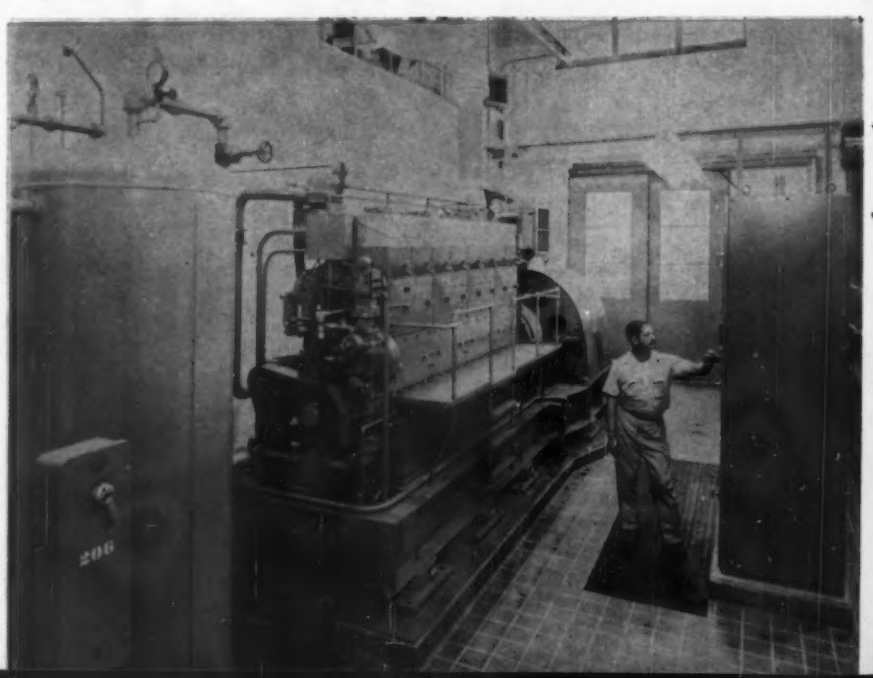


Fig. 1. Chrome and polished aluminum help to make a show piece of this diesel generator set. John Coffman, assistant power plant superintendent, checks gages on the switchgear control panel

Fig. 2. Main power plant, with the two 1000-kw Elliott steam turbines at right, York ammonia compressors left

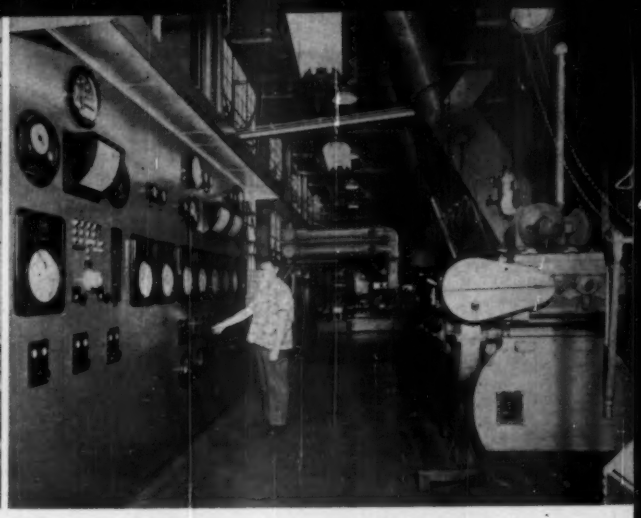


Fig. 3. Master steam control panel which governs the one gas-fired boiler and two coal-fired boilers (right)

this gap went the White engine-generator set, and it has proved so successful that the old 125-kva outside line may be removed.

Additions of the new generator set was one of several steps taken recently to expand the Falls City Brewing Co plant, under the direction of Brooke and Choporis, consulting engineers. Expansion included the construction of a new section, which in part houses the power equipment.

Falls City starts making beer at midnight on Sunday and works through noon on Friday. Some of the bottling units have a capacity of about 600 bottles per minute, and the canning line has an even greater capacity.

The workhouse power plant must operate continually all year long, for it also bears the weekend refrigeration load. The average daily winter load is 900–1100 kw, while the summer load increases to a total which is as much as 1200–1700 kw.

### Unbroken Brewing Cycle

Every piece of equipment in the plant plays an important role in beer processing, but certain phases are termed essential by Falls City management. Once a brewing cycle has been started it must be completed virtually without interruption; even short stoppages could cost the company a substantial sum.

The new 600-kw unit is capable of supporting the bottling and other essential phases entirely on its own. When a voltage regulator on the steam turbines went out, the set performed admirably under emergency conditions. While the steam turbine regulator was being repaired, the diesel set carried 670 kw, or an amount which is approximately 12 per cent overload.

Operations have borne out factory fuel consumption tests, as follows:

50% load (300 kw)—22.00 gal/hr
75% load (450 kw)—30.73 gal/hr
100% load (600 kw)—41.32 gal/hr
115% load (690 kw)—48.98 gal/hr

Equipment supplied with the set includes a Woodward type UG-8 hydraulic governor, Falk #46-A Airflex coupling, Elliott 125-volt d-c exciter, and a 12-in. Maxim 24-M-40 silencer.

Mounted on the side of the engine sub-base and completely piped into the system is a Ross #1008 type CPR jacket water heat exchanger. A similar mounting has been given to the Autopulse fuel return pump, and White has supplied a Blackmer WH-404 hand-priming pump. Isolators, by Raybestos-Manhattan, have been installed under the engine to dampen vibration.

The ITE Circuit Breaker Co switchgear permits a smooth transfer of power when required, and the alarm, shutdown, and control system has been built into a single panel measuring 24 in. by 48 in.

With its trim lines, polished aluminum cylinder head covers, chrome-plated ladder, rails and coverplate handles set off against a gray engine and green air compressor, the diesel set does much to make the Falls City power plant a show place for thousands of visitors. THE END

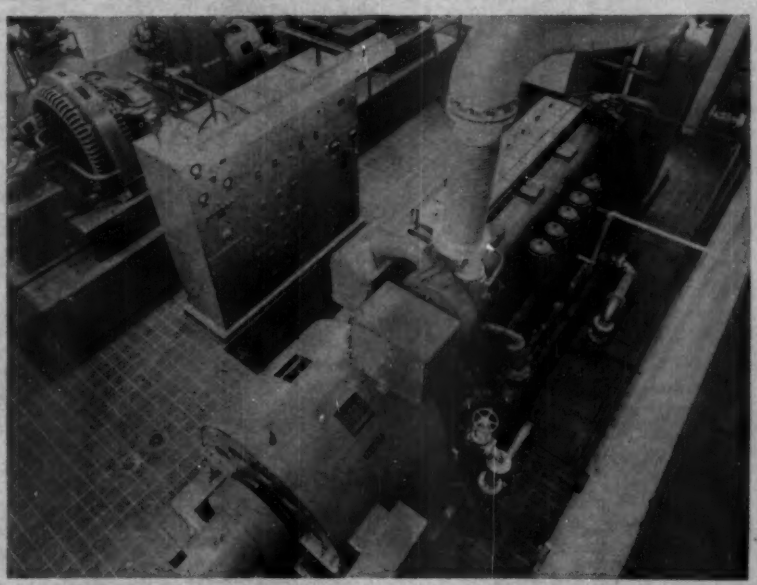


Fig. 4. Another view of the diesel generator set, with Ingersoll-Rand air compressors in background. These compressors power instruments and pumps for beer-making

Power Engineering

LAST OF A THREE-PART SERIES

# BALL, ROLLER, SLEEVE – WHICH MOTOR BEARING FITS THE JOB BEST?

## R. L. NAILEN, MOTOR ENGINEERING SECTION OF WESTINGHOUSE, TELLS HOW TO JUDGE; INFLUENCE OF TEMPERATURE AND END PLAY; HOW TO FORESTALL FAILURE

TYPES OF BEARINGS used on electric motors commonly specified and operated by power engineers were described in the May, 1960, issue, p. 71; and methods of lubricating them for best results were shown in June, 1960, p. 72.

This article is not intended to make firm recommendations as to which type of bearing is best for a given application. However, motor users should have some idea of the relative merits of the two. Advantages of each are listed below:

**A. Ball (or roller) bearings**

1. Low friction — especially at starting.

2. High load capacity — particularly thrust loading.

3. Complete standardization — replacement bearings of many types are available "off the shelf" all over the world. Those made by one bearing manufacturer are interchangeable size for size with those made by any other. But remember that the right type, as well as the right size, is important — a regreasable bearing doesn't belong in a prelubricated bearing housing. Nor does one with a "tight" internal clearance belong in an application designed for loose clearances.

4. Bearing failure does not usually damage the motor shaft.

5. Grease lubrication is inherently simpler and cleaner than oil, and lends itself to placing of motors in wall, ceiling, and vertical mountings. Use of the prelubricated, sealed bearing helps shorten the tedious round of the factory oiler.

6. Loss or deterioration of lubricant will shorten bearing life but does not usually result in immediate bearing failure.

7. "Heat-stabilized" ball bearings are available for use in ambient temperatures above 100 degrees C; silicone base greases are used for lubrication.

8. May be locked in place to provide the very small shaft end play required for close-coupled pump drives, where the pump impeller is mounted directly on the motor shaft extension.

**B. Sleeve bearings**

1. Quiet operation.

2. Relatively insensitive to small amounts of grit and dirt, over-lubrication.

3. Indefinitely long life, when properly lubricated. When badly worn, can be economically relined and put back into service.

4. May be split to enable inspection and removal of bearings without removing motor and brackets or disturbing coupling alignment.

When either type of bearing is available in a motor being selected for a given application, the foregoing factors (plus relative cost and delivery date) should be considered in making a choice.

Temperature of standard ball or sleeve bearings should not exceed

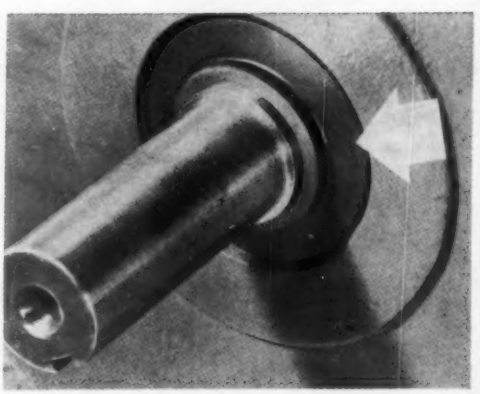


Fig. 1. Neoprene flinger used on small motors to exclude dirt from housing

85 C (170 F). Normally the bearing temperature will level off at least 15 or 20 C (68 F) below that of the winding. A thermometer on or in the bearing housing is the best check.

When ambient temperature for a ball bearing motor exceeds 40 or 50 C (122 F), the motor manufacturer should be advised, so that high temperature bearings may be supplied. These are specially made to stand operation up to 125 C (267 F). Motors so equipped will usually require long delivery times. Remember that conventional bearing greases will not be satisfactory at this temperature. Similarly, temperatures below **minus** 25 C (−13 F) require special bearings and lubricants.

Sleeve bearings are not rated for operation in ambient above the standard 40 C. Any value in the 30 to 60 C range will probably cause little trouble. However, such applications should be negotiated. There have been a few instances of large outdoor motors, subject to below freezing temperatures, which have been equipped with small heaters on the bearing reservoir to prevent congealing of the oil and to save bearing wear at start-up.

On loaded roller thrust bearings, rises of 60 to 70 C or more are not uncommon, especially at the higher speeds. Water cooling of the bearing oil is used to keep the temperature from going still higher, and is to be expected at 1800 rpm regardless of thrust — heating due to bearing speed is excessive even when loading is light. This means that water inlet and drain lines must be provided for in the motor installation, with a water flow usually not exceeding 2 to 3 gpm. Kingsbury bearings also need water cooling.

### Protection Against Failure

Assuming that proper loading and maintenance will be provided, what motor design features and accessories are available to protect against bearing failures? First on the list are sealing arrangements to keep contaminants out of the bearing housings. Totally-enclosed motors, and outdoor motors meeting the NEMA definition for type 2 Weather-Protected Enclosure, are equipped with various types of revolving and stationary seals to exclude water and dirt, Fig. 2.

Motors of other enclosure designs may require more complicated sealing in very dirty environments. For example, seals of the type shown in Fig. 2 have been developed for use in medium and large motors exposed to taconite dust. Small motors can be furnished with rubbing felt seals for this service. Where the entrance of dripping or splashing water is a problem as in the case of drip-proof motors wall mounted with the shaft up, neoprene flingers, Fig. 1, can be specified.

Second is the use of insulated bearings or bearing housings (normally on one end of the motor only) to prevent the passage of shaft currents through the bearings. The pitting caused by these minute currents is especially destructive to antifriction (ball or roller) bearings. Since the presence of voltage-producing bearing current is a function of the motor electrical design, the decision to supply insulated bearings or not is the motor manufacturers'. However, remember these points:

1. When a motor is furnished with an insulated bearing, it is essential that the insulation be maintained throughout the motor life. Excessive contamination by oil or dirt, and the connection to the bearing housings of accessories using metal fittings, may short-circuit the insulation and cause currents to flow. To avoid trouble, the user should clearly understand just how the insulation is located.

2. Sometimes, in spite of the designer's efforts, a motor without bearing insulation may exhibit unexpected shaft currents during operation. Should these be detected, it is usually possible to cure the trouble by providing insulation; the motor manufacturer should be consulted as to the method to be used.

If a bearing failure should occur in spite of all precautions, it is important to know that there is trouble and if possible to get the motor off the line before more damage is done. Bearing failure may ruin the motor shaft, allow stator and rotor to rub, and lead to burnout of the winding.

### Hot Bearings

Temperature detectors for the motor bearings are the solution. When bearings overheat, the detectors may sound an alarm, or be wired into the motor control circuit to take the motor off the line. This may be supplied and mounted by the motor manufacturer, or mounted later in the field. Here are the things to remember when ordering these devices: A. When they are to be mounted later: Be sure to give enough information on the motor order so that

**Fig. 2. Bearing seals commonly used on outdoor motors. Shown at bottom is a grease-filled revolving seal used for protection against magnetic ore dust**

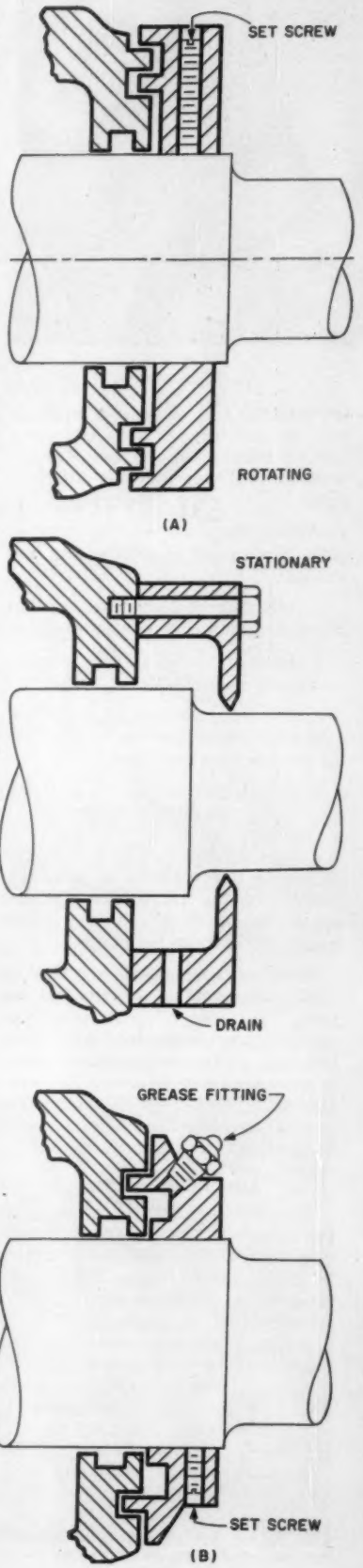


Fig. 3. Dial thermometers may be used to indicate bearing temperatures in 500-hp totally-enclosed sleeve-bearing motors. Attention to temperature prevents damage

the bearings and/or bearing housings can be properly drilled. Complete catalog number of the temperature detector will provide this information.

B. When they are to be supplied with the motor — specify the following:

1. Whether dial thermometer or alarm contacts only are required.

2. Desired contact arrangement (normally open, or closed, etc).

3. Any coördination of the detectors with similar devices used on the driven machine bearings.

4. Some detectors consist of a temperature probe directly connected by a capillary tube to the relay or thermometer element. If it is desired to mount that element at some distance from the motor, that distance should be stated so that the proper length of tube can be ordered.

These detectors are seldom used on small motors, below 100 hp. For one thing, the cost of protection rises rapidly as motor size falls. Also, spare bearings and even complete spare motors are more likely to be available in case of failure. And on motors of this size range, the detectors may be too large to fit into the motor.

### Allow for End Play

To allow for thermal expansion of the motor shaft as it warms up during operation, at least one end of it must be free to move axially. The amount required is approximately 0.005 in. for each foot of length between the bearings. This is a minimum. Ball bearing motors for normal application will have at least this much. Sleeve bearing motors will have 1/16 to 1/2 in. nominal end play, depending upon rating and speed.

Reason for the relatively large play is to insure that in spite of manufacturing and winding variations, the rotor-shaft assembly can be made to "float" during operation, that is, to run without contact between the end of the bearings and the ends of the journal fits on the shaft. Such contact means axial thrust is present; the bearing is not designed to stand this.

Since sleeve bearings are not capable of sustaining axial thrust, NEMA has standardized on end play for pump motors, an application most likely to be subjected to such thrust. The reason (NEMA Standard MG1-6.11): "Operating experience on horizontal sleeve bearing motors has shown that sufficient thrust to damage bearings may be transmitted to the motor through a flexible coupling." (At operating speeds, the mating parts of the coupling tend to lock together by friction, which does transmit axial thrust.)

Therefore NEMA recommends ball bearings for all such motors 200 hp and below at 1800 rpm, and 100 hp and below at 3600 to 3000 rpm. If sleeve bearings are used, standard end play is 1/2 in. for motors 250 through 450 hp at 3000 and 3600 rpm, and for 500 hp and up at all speeds. Outside this range, end play is 1/4 in.

This standard was set up for pump drives, as stated by NEMA, and does not necessarily apply to motors used for other applications. Specifically, large sleeve bearing motors, of speeds below 1800 rpm, will normally have 1/4 in. end play. At 1800 rpm, end play may be 1/4 or more depending upon horsepower rating.

It is advisable to check with the motor manufacturer beforehand to avoid ordering the wrong type of coupling to go with the motor. The so-called "limited end float" coupling is recommended for sleeve motors, in preference to "free floating" type S, to make sure that the motor rotor cannot move axially to the limit of its end play and thereby impose a thrust load on the motor bearings.

When special drives, particularly pumps, require that total end play be limited to zero or a few thousandths of an inch, locked ball bearings, Fig. 4, are used. The design modifications necessary to secure this limited end play require that the necessary value of end play be negotiated with the supplier. THE END

*Editor's Note:* This article is the last of three articles by Mr. Nailen on the general subject of bearings for electric motors.

First was the article What to Expect of Motor Bearings, May, 1960 issue, detailing types of motor bearings used on the equipment usually operated by power engineers.

Second article was What Is Proper Lubrication for Your Electric Motor Bearings?, June, 1960 issue.

Those two, and the present article, will be combined in a reprint in the near future. When it is ready, it will be announced in the magazine. If you want to reserve a copy of it, write The Editor, POWER ENGINEERING, 308 East James St, Barrington, Illinois.

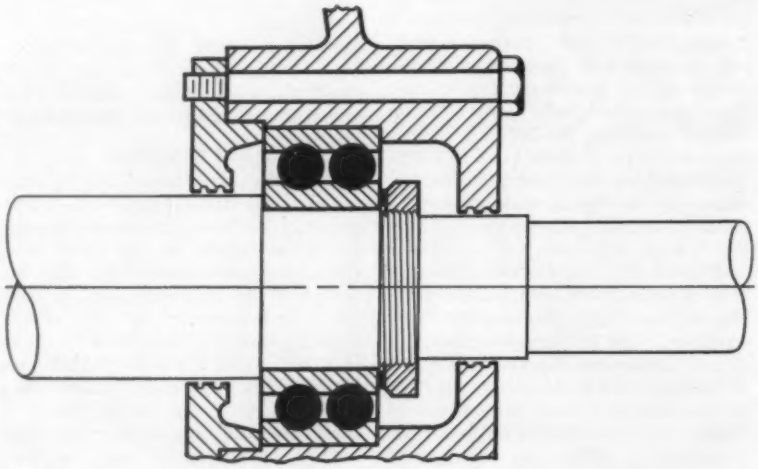


Fig. 4. Ball-bearing assembly locked for zero end play, as explained in text

BREAKING THE STEAM PRESSURE BARRIER

# WHAT IT TAKES IN PIPING FOR A SUPERCRITICAL UNIT

## C. A. DAUBER OF CLEVELAND ELECTRIC HERE INTERPRETS THE UNIQUE PIPING SYSTEMS BEING USED IN AVON NO. 8 UNIT, 3500 PSI, 1100 F

A SIGNIFICANT event in power generation occurred on December 18, 1959, when the Cleveland Electric Illuminating Co initially generated the first kilowatthours with its Avon No. 8 Unit. It has the distinction of being the third in the United States to employ a supercritical steam pressure, which is a big step forward in the march to improve fuel consumption.

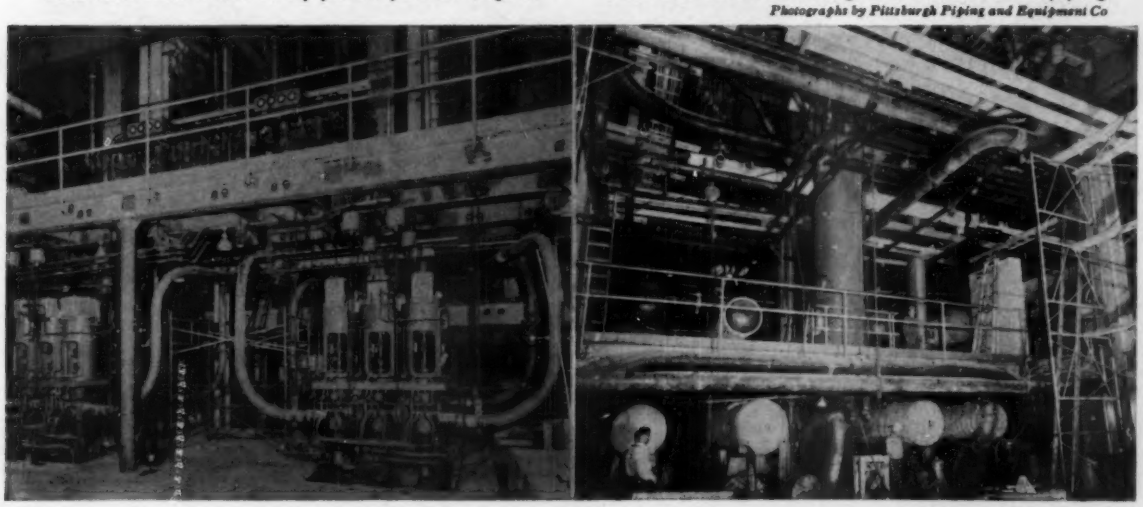
Not too long ago, a nominal steam pressure of 2400 psi was considered the maximum feasible, inasmuch as the difference in densities between steam and water at higher pressures is too small to permit proper operation of a conventional type of steam generator. Through the use of the monotube principle, a radical departure from the conventional drum-type boiler, it is now possible to generate steam above the critical pressure of 3220 psi. Cleveland Electric Illuminating Co chose 3500 psi and 1100 F as the superheater outlet pressure and temperature. Also, the new unit has one stage of reheating to 1050 F.

In general, each superheater tube in a monotube boiler is connected directly to its respective water heating tube. In other words, feedwater

Fig. 1. Main steam stop and by-pass valves by Sulzer send fluid from boiler to by-pass separator (Fig. 2)

Fig. 2. Vertical tank in center is by-pass separator. Above is main steam mixing header heater drain piping

*Photographs by Pittsburgh Piping and Equipment Co*



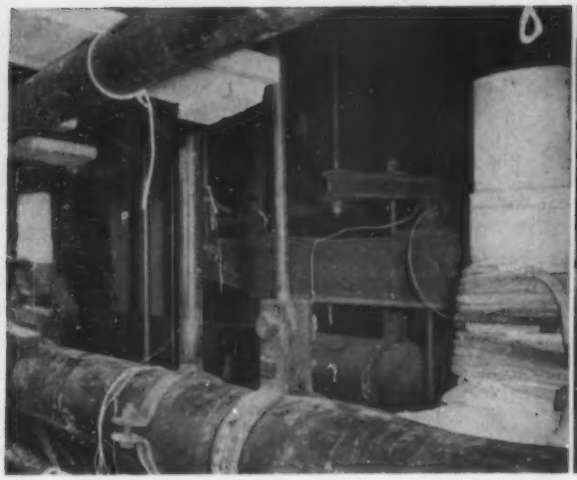


Fig. 3. Boiler feed discharge header feeding to Sulzer system valves for the control of water to boiler

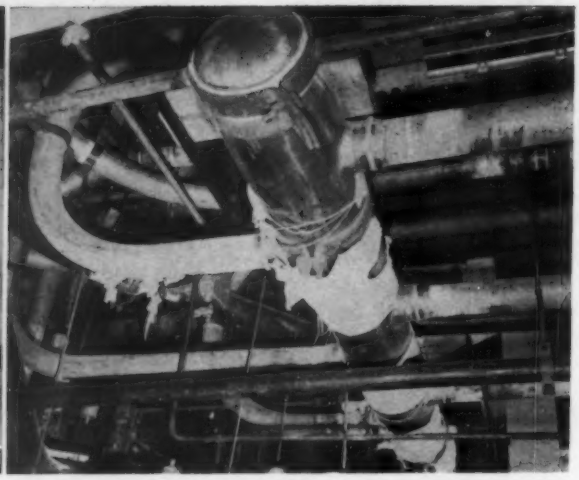


Fig. 4. Stainless steel 16-in. O.D. by 10-in. I.D. mixing header between Sulzer stop valves and turbine

entering the boiler remains in the same tube circuit until it leaves as steam at the desired pressure and temperature. Inasmuch as there is no heat of vaporization above critical pressure, the transition from water to steam takes place the instant the fluid temperature exceeds 705 F.

Water is pumped through the entire tube circuit while the unit is being started. To establish a flow of superheated steam to start the turbine, the fluid leaving the boiler must initially by-pass the turbine to prevent damage which would result from putting water through it. The Sulzer by-pass valves, Fig. 1, by-pass the fluid from the boiler to the by-pass separator, which is the vertical tank in the center of Fig. 2. Here steam is separated from water, the water going directly to the condenser. The separated steam passes through the reheater to keep it cool during the start-up cycle, from which it too goes to the condenser.

The major piping systems serving this supercritical unit are unique. Elimination of the conventional boiler drum necessitated use of new types of controls, which in turn required new piping arrangements. Boiler outlet steam pressure is regulated by controlling the inlet water pressure to the boiler. Variable speed pumps discharge 1,715,000 lb of water per hour at 4500 psi through extraction heaters, Fig. 2, into the 12¾-in. O.D. by 9-in. I.D. carbon steel header shown in Fig. 3.

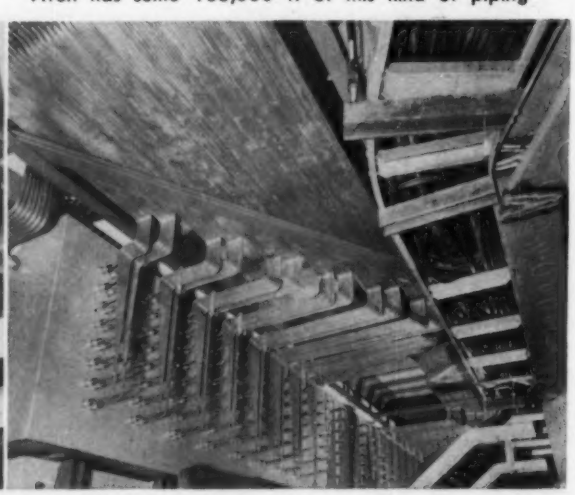
The weld in the line on the right in this picture is being stress-relieved; the line on the left is being preheated for welding. The four outlets from this header each have regulating valves which control flow to each of the four sections in the boiler. Flow to each of the sections must be controlled to suit the heat absorption of its particular tubes.

Steam at 3775 psig and 1100 F is transported through eight 6⅝-in. O.D. by 4-in. I.D. type 316 leads, each 300 ft long, to the Sulzer stop and by-pass valves and thence to the 16-in. O.D. by 10-in. I.D. mixing header, Fig. 4, also of gleaming type 316 stainless steel. Four leads from the mixing header carry the steam to the turbine.

Figure 5 shows the eight hot reheat leads (10-in. schedule 140, 2¼ chrome, 1 Moly) from the boiler. These lines terminate at the 20-in. O.D. reheat mixing header, from which two 20-in. O.D. leads carry

Fig. 5. Hot reheat weld wrapped with asbestos paper and ready for stress-relieving coils. Main steam below

Fig. 6. Instrument piping under the control panel room. Avon has some 135,000 ft of this kind of piping



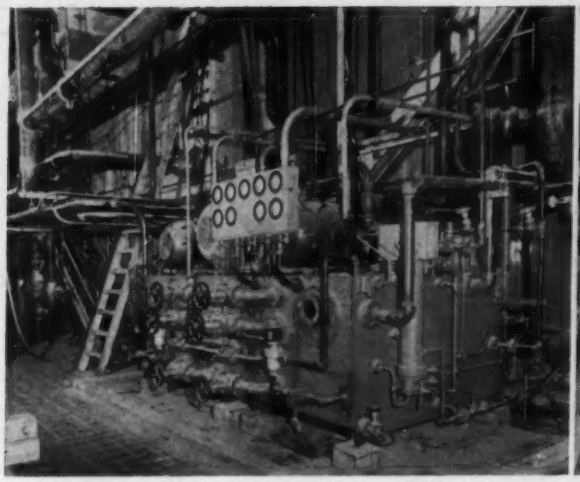


Fig. 7. Sulzer hydraulic controls, served by this oil storage tank and pumps, required many feet of piping

Fig. 8. View looking up at supply and control lines leaving steam controlling unit for temp and pressure

the hot reheat steam at 1050 F to the turbine.

The Avon piping story is by no means confined to the handling of steam. For example, Fig. 6 shows a portion of the approximately 135,000 ft of instrument and control piping. The Sulzer hydraulic controls, the pump for which is shown in Fig. 7, required many feet of piping and tubing for the Cellulube oil. Some of the Sulzer supply and control lines are shown in Fig. 8.

Since water is converted directly into steam without being collected in a drum as in a conventional steam generator, elaborate water treatment facilities have been provided. Dissolved solids are reduced to 0.05 ppm by continuous conditioning of water in the cycle, as well as treating the necessary make-up. This unit has been provided with the most extensive water treatment plant in the Cleveland Electric Illuminating Co system. A portion of the demineralizer installation is shown in Fig. 9.

The arrangements described present only a part of the total story of Avon No. 8 piping. Also involved were the careful selection of materials and welding techniques. New methods had to be devised to clean out the piping prior to its initial start-up to insure a minimum amount of impurities in water and steam. All of these factors required a maximum amount of coöperation between the Pittsburgh Piping and Equipment Co, which fabricated and erected the piping systems, and the engineers of the Cleveland Electric Illuminating Co, who designed these new systems.

This new generating unit at the Avon plant brings the plant's total generating capability to 635,000 kw. The plant's six other units produce 400,000 kw. With No. 8 unit on the line, the company's total net generating capability tops the two million mark — 2,151,000 kw.

Engineering work on No. 8 unit began in August, 1955. Construction was started in February, 1956. The entire project cost $39,000,000. Boiler was manufactured by Combustion Engineering Co. The generator was constructed by Westinghouse Electric Co.

No. 8 unit was expected to produce a kwh with 0.7 lb of coal, which is nearly a 10 per cent reduction in coal use. Operating experience thus far indicates that the unit will meet its estimated performance. THE END

Fig. 9. Cochrane by-pass demineralizer tanks for demineralizing cycling water from condenser to boiler

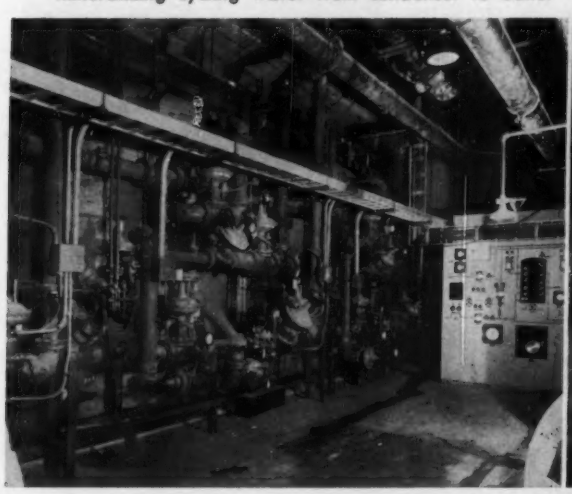


Fig. 10. Welding main steam lines under the turbine room. These transport steam at 3775 psig and 1100 F

# OPERATING EXPERIENCE WITH A H-T-H-W SYSTEM

## HERE'S ADVICE ON THIS TYPE OF SYSTEM

FROM R. N. CLARKE AND
T. J. McMAHON OF BEHR-MANNING

BEHR-MANNING CO, of Troy, N. Y., a division of Norton Company, and manufacturer of coated abrasives and pressure-sensitive tapes, recently doubled the capacity of its high-pressure hot-water system by installing a 115,000,000-Btu International LaMont boiler, housed in a stainless steel-clad building.

Use of high-pressure hot water at Behr-Manning dates from 1939, when the plant changed over from a 150-lb steam to a 365-F water system. This change-over, designed and installed by the J. O. Ross Engineering Co, was the tenth such installation in the United States.

The company's production has grown greatly since 1939; demands for space and process heating, naturally, have grown with it. To keep ahead of these demands, the present plant consists of three 40,000-lb-per-hr converted Riley steam boilers, and the new 115,000,000-Btu International unit, which is operated at 150 psi. The water is circulated through the boilers to a 20,000-gallon expansion tank by two Ingersoll-Rand 3000-gpm pumps. Three system pumps boost the water pressure to 250 psi and circulate it through some 20 miles of piping, which ranges from 1 to 10 in. in diameter.

Combustion is controlled by a pneumatic combustion control system, which basically controls the rate of firing by regulating the rate of fuel and air supply, using the return water as the control medium. Controls are equipped to shut off fuel feed in the event of reaching a low water-flow or low level in the expansion tank.

Heating more than 1,500,000 sq ft of office, factory, and warehouse space accounts for 40 per cent of the plant load. Factory and warehouse areas are heated directly by high-pressure hot water through unit heaters; office areas are heated by secondary hot water systems.

Process heating is supplied to the users by both direct heating units (air-blast coils) and by heat exchangers which provide hot water, hot oil, or steam — as the process requires. There are 60 heat exchangers of vari-

Top photo (Fig. 1) is an aerial view of the Behr-Manning plant, showing large area covered. Note distribution piping and expansion loops on roofs of several of the buildings. Bottom photo (Fig. 2) shows vertical riser and the roof piping on one of the buildings

ous sizes, which produce steam or secondary hot water, and approximately 350 unit heaters are used for space heating.

To aid in balancing flows in the various sections of the plant, we have installed flow meters and temperature-differential recorders, Fig. 3, on many of the primary and secondary mains. Because this hot water system is a completely closed circuit, we have a very low make-up which, in turn, makes water treatment a minor problem.

Control of temperatures at the various process heat locations is accomplished by means of pneumatic single-seat control valves using Teflon packing to minimize steam wear and leakage.

### Standards for Users

Although high-pressure hot-water systems are becoming more common, we have developed, through experience, some standards which other H-T-H-W users may find quite acceptable. These are: 1. Pneumatic control valves. Use only single-seat, and install on return side of circuit. 2. Packing. Use Teflon whenever possible. 3. Install an orifice flange at every main branch, to monitor flow when required. 4. Lock-shield solid-wedge gate valves, on short nipple, used at all high points for venting. 5. Gate valves for main shut-offs. (Globe valves used only for throttling purposes, to cut down system resistance.) 6. Valve specification standards are: Up to 2 in. — screwed-end bronze — 300-lb gates or globes; 2½ in. and over — 300-lb flanged or welded-end cast steel gates or globes.

Other factors worth mentioning are these: *Piping* is Sch-40, A53 tested, plain ends. All piping is to be welded except where connecting small-size valves; when connecting screwed-end valves, we use a 6-in. piece of Sch-80 pipe, threaded one end to valve, and weld this assembly into the run of Sch-40 pipe. Also, expansion is taken up by spring hanger and expansion loops; and, on ends of long, large mains, or where stubs are left in line for future connections, we install a dirt trap on the end of the supply line.

### System Is Flexible

Recirculation loops are used at the ends of long runs to provide constant circulation and keep lines from cooling down when there is no process demand. In order to provide maximum flexibility, we try to use clevis hangers, and eye rods, wherever possible. We use pipe rolls where we are forced to do so because of the space limitations.

Flexibility of the H-T-H-W system permits us to run mains underground, vertically up the side of buildings, and along the building roofs to permit distribution, Fig. 2, to our process and load-centers.

Advantages of the high-pressure hot-water system, as we see them, include: No maintenance of traps or condensate equipment; new lines could be run without regard to grades or land contours; control over the transmission mains can be centered in the boiler plant at the pumps; less water treatment is required (make-up on our present plant is 1/10 of 1 per cent, against 35 to 50 per cent on the old steam system; and there is no corrosion trouble on return lines The system is oxygen-free. We have not yet replaced a single foot of pipe because of either corrosion or erosion

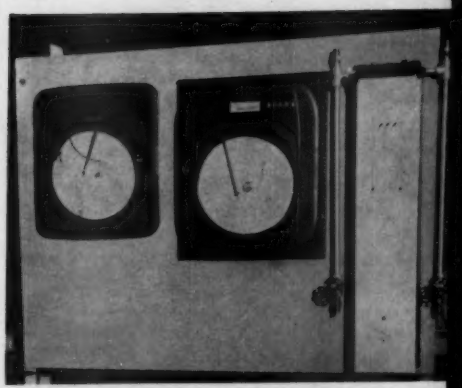


Fig. 3. Temperature-differential recorders and flow meters were installed on many of the primary and secondary mains throughout various sections of Behr-Manning's plant to balance flows

### Water Level

Water level in a closed system re mains constant. The large thermal reservoir of water in the pipes cuts down boiler shock, because sudden (or high) demands are buffered by the system. At 365 F, every cubic foot of pipe carries 18,610 Btu on a water circuit, as opposed to only 434 on a 150-lb steam circuit — a ratio of 43 to 1.

We are fully satisfied with the performance of the high-temperature hot-water system, and we feel that the advantages listed are being clearly demonstrated at Behr-Manning Company. And if we were to start anew, possibly the sole change we would recommend would be the installation of a higher temperature system.

THE END

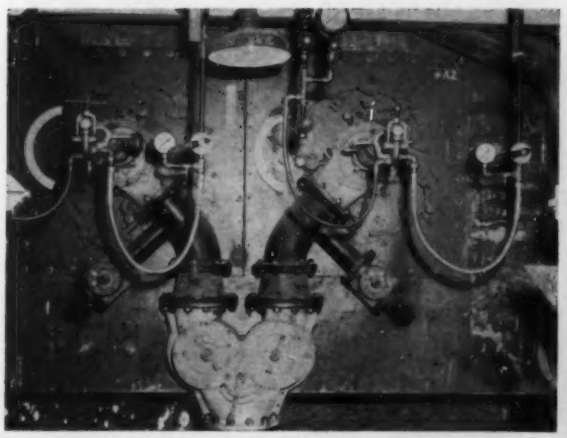
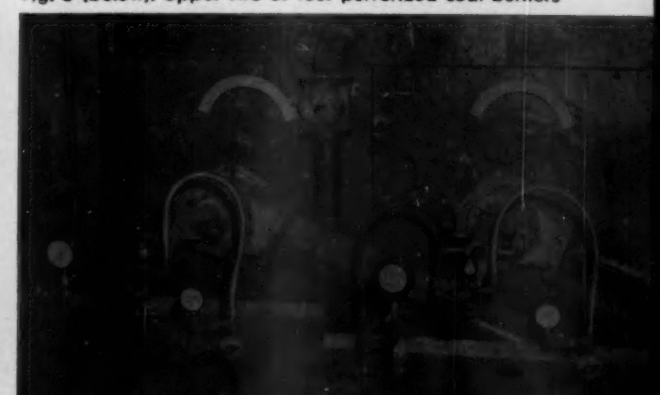


Fig. 4. This is the lower pair of the pulverized coal burners

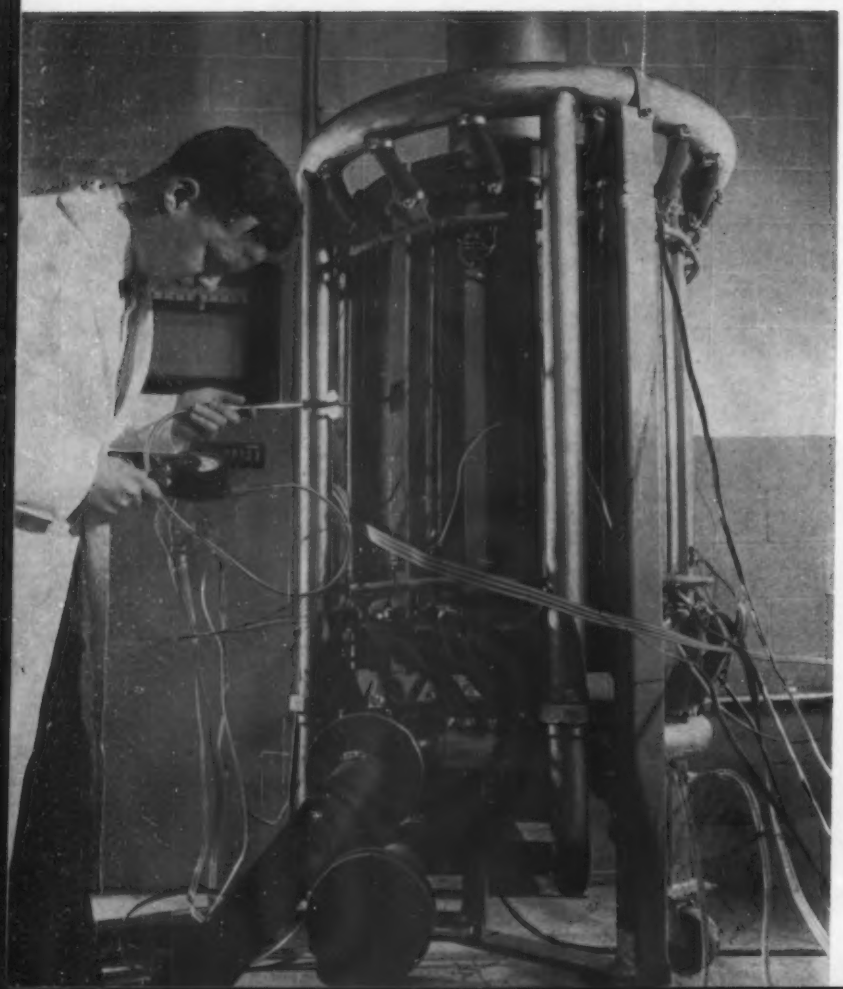
Fig. 5 (below). Upper two of four pulverized coal burners



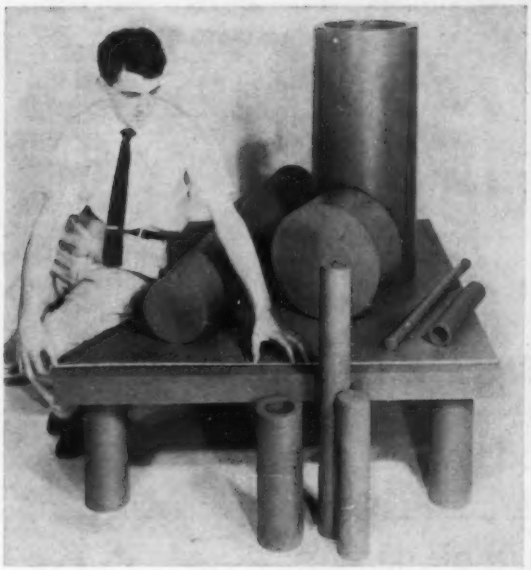
**New** gas compressor station No. 6 for City of Long Beach, Cal, uses octagonal design to achieve very short radial transmission of gas to and from compressors. Building contains four 550-hp gas engine-driven reciprocating compressors. M. A. Nishkian designed the project

**Liquid sodium pump**, the world's largest, is displayed in cutaway model in Borg-Warner Exhibition Hall in Chicago. Pump is one of four Byron Jackson units being used to move coolant through reactor of Enrico Fermi Atomic Power Plant in Michigan. Unit does 11,800 gpm

# Power Engineering's

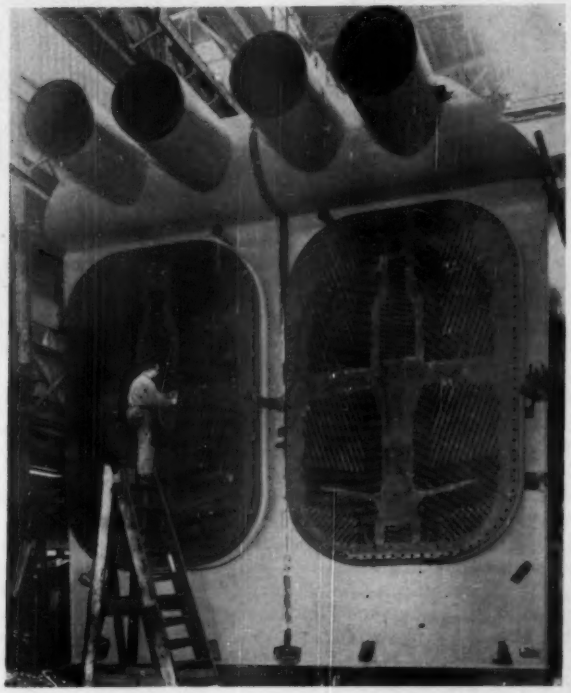


**Most powerful** thermoelectric generator yet is this experimental unit developed by Westinghouse for the Bureau of Ships, U. S. Navy. It delivers 5 kw of power by direct conversion of heat into electricity without major moving parts. Thermoelectric modules form the walls of a hollow cylinder, their hot inner surfaces exposed to the flame of burning kerosene, their outer surfaces cooled by water. Heat flows through from hot to cold faces, and electricity is generated in the process. Only moving parts in the entire unit are pumps for the cooling water and kerosene fuel burners. Both are operated by motors which receive power from generator itself



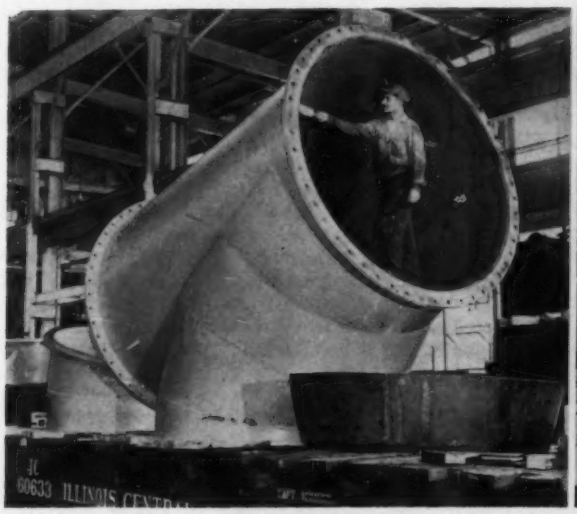
**Nylon news** is the availability of massive shapes of the material for industrial uses such as large bearings competitive with bronze. This display of shapes made from new MC Nylon was shown for the first time by Polymer Corp at the Design Engineering Show

# NEWS REEL

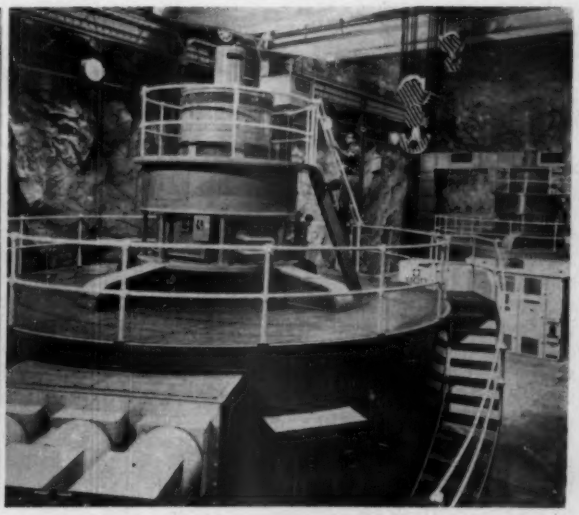


**Condenser being installed** at Enrico Fermi Atomic Power Plant is a 110,000-sq ft unit shop fabricated in five main sections before shipment from Worthington. Design incorporates special nuclear plant requirements

**Persuading salmon** to use fish ladders at Ice Harbor Dam on the Snake River in southeastern Washington will be done by 11 96-in.-diam propeller-type pumps by Worthington. Each creates current by moving water 300 cfs toward ladders




**By building underground,** Pacific Gas & Electric reportedly saved a million dollars in construction costs on its Haas Powerhouse on the Kings River in Calif. Plant is carved out of solid rock 500 ft down, has 2 64,000-kw hydro units



# CHOOSING CONDENSERS ECONOMICALLY

## FACTORS WHICH AFFECT COST AND OPERATING EXPENSE OF SURFACE CONDENSERS ARE EXPLAINED

BY S. M. AUSTIN OF ALLIS-CHALMERS

WHICH CONDENSER is best suited for your installation? Let's start with the operations required of a condenser. The principal duties of the condenser are to create the lowest possible turbine operating back-pressure, and also to return the steam to the liquid state so it can be pumped back into the boiler and reused over and over again. Both of these functions should be accomplished at the best possible point of efficiency, consistent with the ever-present problem of cost.

### Variables to Consider

There are many variables which must be given proper consideration to correctly proportion a condenser so that it will meet these efficiency and cost requirements for a specific installation. It is well to discuss many of these variables so that a condenser's suitability for a particular installation may be more easily understood.

However, the final decision to use a certain size condenser requires considerable study and evaluation of all factors involved. This evaluation study may utilize data-processing machines and may take into account turbine heat-rate improvement for various back-pressures, cost of pumping cooling water, and capitalization of reduced station capacities. In such a study, complete information on local conditions is obviously of vital importance.

Design variables include steam load, back-pressure desired, and cooling-water temperature. These three items are bound to vary considerably over the seasons, but a single design point must be established for each. Also, the condenser can be either single-, two-pass, or even three- or four-pass. The tube diameter can be ¾, ⅞, or 1 inch outside diameter, and at least four different tube lengths are available for every size condenser. Moreover, various tube materials can be selected.

Cooling-water velocity through the condenser is subject to considerable design variation, and a percentage *cleanliness factor* must be selected. In addition, consideration must be given to the physical shape of the condenser and to the materials, fabrication, and transportation aspects. Following are several curves which illustrate the importance of each variable; they show how each of these variables can influence the initial cost, operating cost, and physical size of the condenser.

### Condenser Design Example

Used as an example will be a 150,000-kw tandem compound, double-flow reheat turbine-generator, using 1800-lb, 1000 F steam, with 735,000-lb-per-hr flow to the condenser and an assumed 950 Btu heat rejection per pound.

Considering first of all the degree of back-pressure for which to design, suppose that there is available 80 F cooling water; and figuring approximately 15 F maximum rise (and 5 F minimum terminal difference), the resulting sum would be 100 F, which is very close to 101.1 F, the temperature equivalent to 2 in. of mercury-absolute pressure.

With a single-pass condenser using ⅞-in. 30-ft-long tubes, 7-fps velocity, and designing for 2-in. back-pressure, with 80 F water (and 85 per cent cleanliness factor), 80,000 sq ft of condensing surface will be required.

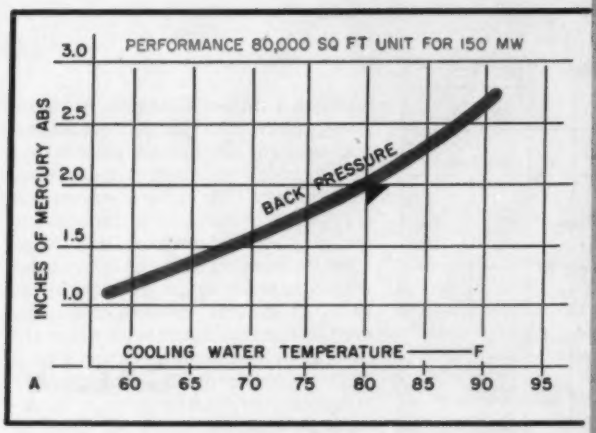
Two inches' back-pressure (with 80 F water) is probably the most common design point; and, without going into a detailed evaluation study, normally a condenser so proportioned represents a reasonable balance between initial cost and resulting performance.

Figure 1 shows the back-pressure resulting from this same 80,000-sq ft condenser under varying circulating-water temperature conditions. Thus with 70 F water, and with 90 F water, back-pressures of 1½ in. and 2¾ in., respectively, will result.

Actually, a condenser designed for two inches with 80 F water, regardless of the actual water temperature available, will have a back-pressure quite consistent with the actual cooling-water temperature. This method is often used for preliminary estimates.

Figure 2 shows the influence which cooling-water design temperature has on the size and cost of a condenser. For example, designing for 2 in. (with 75 F water), only 65,000 sq ft of condenser surface is required; as compared to 80,000 sq ft when designing for 80 F water, the cost is 18 per cent less. However, designing for 2 in. (with 85 F water) would require 103,000 sq ft at 28 per cent higher price than the 80,000 sq ft unit.

Choice between single- and two-



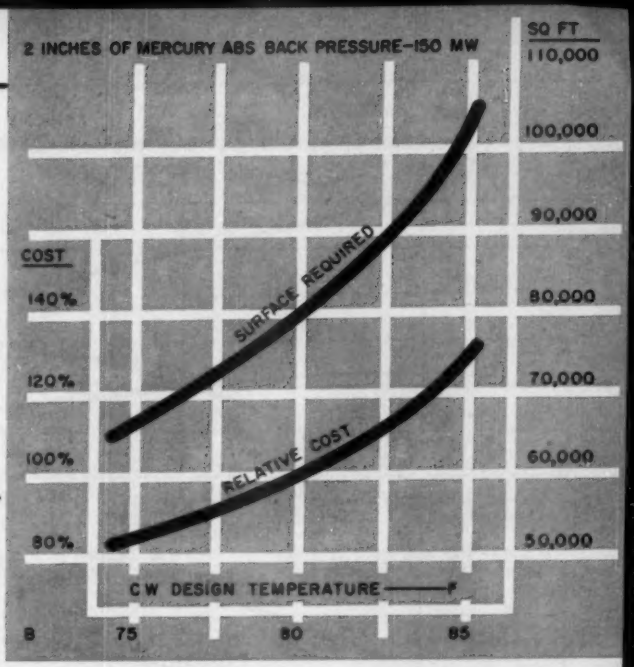




Fig. 1 (above). A well-proportioned condenser operates at a back-pressure consistent with the actual cooling water temperature. Fig. 2. The choice of cooling water design temperature appreciably affects size and cost of condenser

pass condensers is dependent principally upon the quantity of cooling water available and the pumping head external to the condenser, although a single-pass unit is generally somewhat smaller physically and cheaper in first cost. A 100,000-sq ft two-pass condenser using $\frac{7}{8}$-in. diameter, 26-ft-long tubes would do the same job as the 80,000-sq ft single-pass condenser using $\frac{7}{8}$-in. diameter, 30-ft-long tubes as mentioned in the example.

As shown in Fig. 3, the two-pass condenser would be 21½ per cent more costly and, incidentally, 18 per cent larger in physical size. The two-pass condenser would need 86,800 gpm of cooling water, requiring 507 bhp to pump it through the condenser only, as compared to 116,500 gpm of cooling water for the 80,000-sq ft single-pass condenser and 364 bhp. When the external head of these two condensers reaches 16.4 ft, the total bhp to pump the circulating water becomes identical. As the external head continues to increase, it would favor the two-pass condenser, with its lesser quantity of circulating water.

For this reason two-pass condensers are usually used with cooling towers, and their higher heads, because of the lower bhp requirements, even though the first cost might favor the single-pass condenser. Conversely, single-pass condensers are generally used in power stations adjacent to the oceans, large lakes, and rivers.

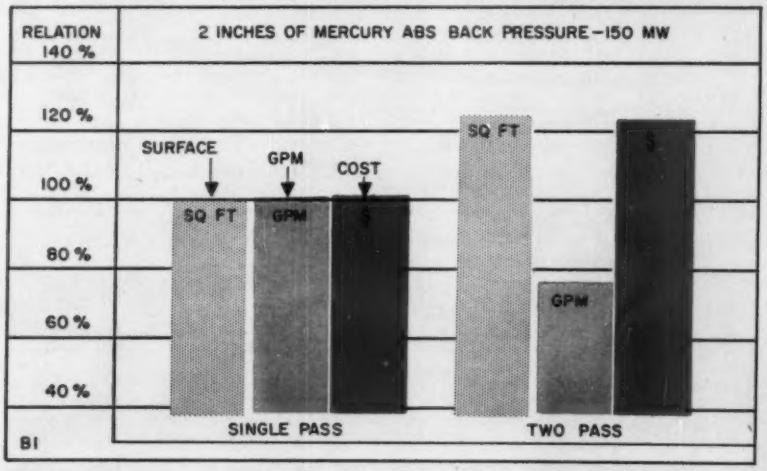
### Tube Size and Length

Three tube diameters normally considered for condenser use are $\frac{3}{4}$, $\frac{7}{8}$, and 1 in. outside diameter. The choice between these is not easy, although as condensers become larger, the tendency is to utilize the large diameter. However, many power companies use the smaller $\frac{3}{4}$-in. tubes in some very large condensers.

Figure 4 shows a comparison of condensers, using the three different tube diameters designed for the same conditions as the original example, which required 80,000 sq ft of surface, with $\frac{7}{8}$-in. tube. The $\frac{3}{4}$-in. tube size, having the best heat transfer but using a lesser quantity of cooling water, would require the largest amount of surface, 85,000 sq ft. Using 1-in. tubes, only 75,000 sq ft is needed, although the cooling-water requirement of 129,300 gpm is the highest.

Brake horsepower requirements to pump cooling water, based on an assumed 15-ft external head, are the least for the $\frac{3}{4}$-in. tube condenser and increase as tubes become larger. However, condenser first cost is inversely proportional to the tube diameter. Decision must be made from a consideration between first cost and cooling-water pumping costs.

Fig. 3. Making a selection between single- and two-pass condensers requires careful evaluation of operating costs in comparison with first costs of condenser



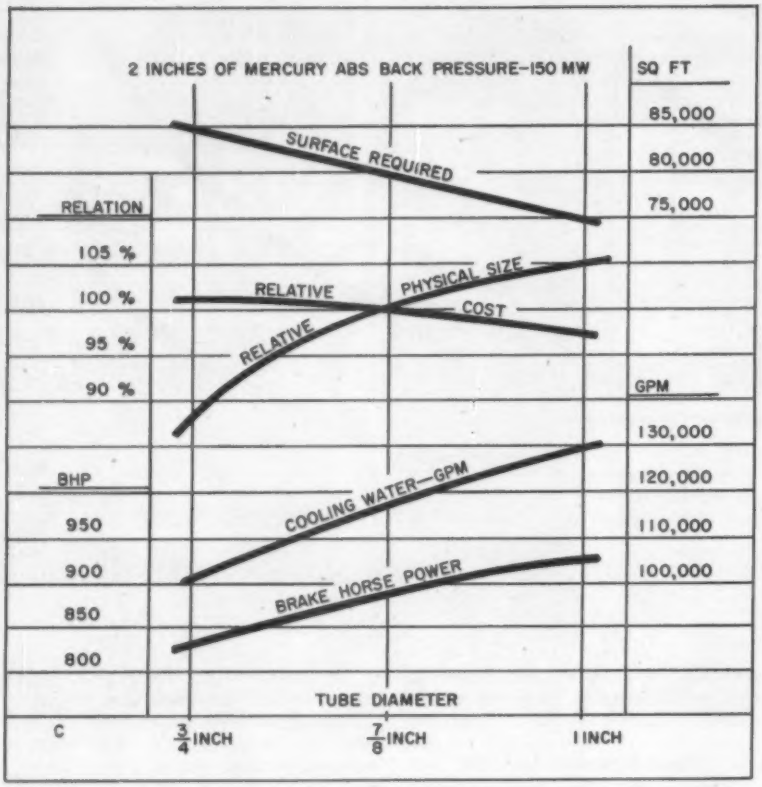



Fig. 4. Each of 3 different available condenser tube diameters has advantages

Generally, larger tubes have less tendency to plug or foul, so some credit must be given for this feature, depending upon local water conditions. Thus open-minded consideration should be given to all three tube sizes. As mentioned, for each condenser square-footage size, there are four different tube lengths available. The use of *even* lengths, and recommended incremental condenser surfaces, is an attempt at condenser standardization.

Referring again to the original example, Fig. 5 shows the condenser variations which result from the use of four different tube lengths. It appears from this chart that preference is with the longer tube lengths, which is essentially correct.

Consideration must be given to space required to pull tubes, and to possibly a deeper basement requirement, since the longer condenser may take additional neck-piece diversion in order to obtain proper steam distribution. This latter is sometimes a problem overlooked in foundation design, but it is obvious that steam must be distributed to the entire tube length in order to get good performance. In general, the longer lengths are recommended although there are definite limitations when using a two-pass condenser due to cooling-water temperature rise and minimum terminal difference.

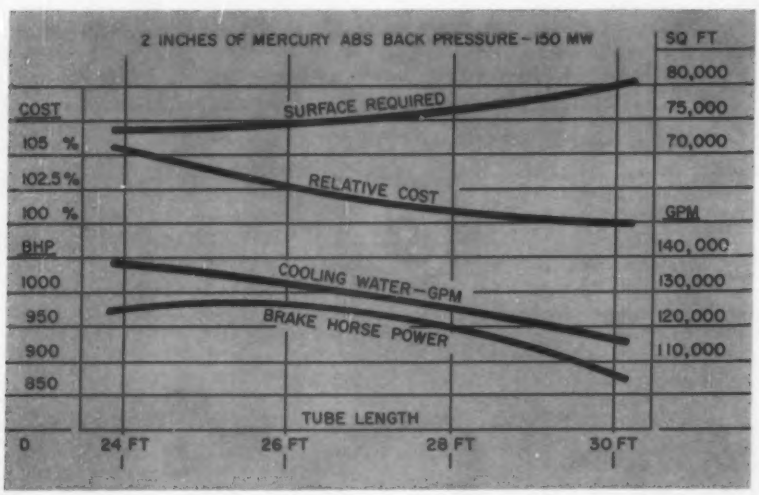



Fig. 5. Graph shows that condenser first cost favors use of longer tube lengths

*Editor's Note:* — There are a variety of materials used in the manufacture of condenser tubes, the most popular being admiralty metal. Several important economic considerations enter into its use.

Of basic importance when designing a condenser is correct determination of cooling-water velocity. Deciding on a particular velocity figure is contingent on many things, and one must ascertain the possible effect on condenser tube life.

Different cleanliness factors may result in variations in sizes and prices of condensers. Therefore, it is essential to determine correctly the cleanliness-factor percentage that will assure better condenser operation.

### Sizes and Shapes

Because condensers are such a vital part of the modern power plant, it is necessary for the designer to determine accurately the size and shape of condenser that will do the job best.

Condenser shape is an important economic consideration in that steam distribution must be adequate and condensate pumps must have sufficient sealing head. Condenser erection is a problem which must be considered in conjunction with condenser proportioning.

Modern welding techniques have minimized the problems encountered by the condenser designer who must properly select the size and shape that is consistent with attaining optimum performance and suitable for a given installation.

Increases in size of condenser units have confronted designers with problems, especially those involving transportation. However, railroad cars for shipping the units have now been properly engineered to provide the necessary space.

These and other factors involved in economical selection of steam condensers will be discussed in a future issue. THE END

THIS IS FOR THE SYSTEMS ENGINEER

# SELECTION AND MAINTENANCE OF INSTRUMENTATION AND CONTROLS

## CATALYTIC CONSTRUCTION CO's EXPERT WALDRON DISCUSSES PRACTICAL ASPECTS OF ONE PHASE OF AUTOMATION

INSTRUMENTATION USAGE in the power field has increased tremendously in the last ten years. In 1950, a good estimate of the instrumentation material cost in process industries would be approximately 3 per cent of the total plant material cost. Today, this is about 12 to 15 per cent, reports A. James Waldron, division engineer in instrumentation for Catalytic Construction Co. As Waldron goes on to say:

In the year 1960 alone, the *chemical industry* expects to spend over 200 million dollars for measurement and control equipment. It is expected that *all manufacturers* of instrumentation, both process and scientific, will enjoy a $12 billion level in our economy by 1970. The rate of increase in the dollar volume of instrument purchasing, from a current $4 billion level (of annual capital committed to measurement and control) is predicted to be at least $800 million per year for the next decade.

### A New Philosophy

Obviously, instrumentation is here to stay. However, there is a basic change in philosophy of instrumentation. That change is from the old concept of applying instruments to a process for process betterment, to the new concept that the instrumentation is an integral part of the process. The design criteria of type, range or span, sensitivity, accuracy, and response characteristics of a particular instrument are not established by themselves. They have to be considered and matched with the specific equipment to be controlled.

Significance of measurement is the first consideration — what parameter is most indicative and responsive to the process dynamics? After determination of significance, then method of measurement is considered. If it is *temperature*, should it be an adjustable narrow-span, filled-bulb element that will generate our transmission signal, or should it be thermoelectric, resistive, or thermistive in nature?

### Correct Decisions Needed

If it is a filled-bulb, which SAMA class element should it be — Class I (liquid-filled), Class III (gas-filled), or Class V (mercury)? It takes an experienced, sophisticated instrument engineer to make these decisions. The point made here is that the process industries have long since passed the phase of deciding *if instrumentation can improve the process.*

This integrated instrument engineering is a coöperative venture. The instrument engineer must work with the process engineer and understand the process, the equipment involved, the time constant, and characteristics of the system. The process engineer must be told the mechanical and control limitations of various devices.

This technique is sometimes called *systems engineering* to denote the over-all process system responsibility. It is also called by other esoteric terms, but it all boils down to a basic concept — *good* engineering; this means coördinated engineering. No man is a technical island; isolation of any one engineering science is not only inefficient, but it can be dangerous.

Thus, the systems engineer has become a paradox, a specialist who is a generalist. He must participate in process design so he can measure and control it. He must know control theory, then hardware, so that the interrelation can be understood and evaluated. He must be familiar with the discipline of electrical engineering for control and interlocks, for the new electronic instrumentation appearing on the market.

Also, he should know mechanical engineering for pump, compressor, heat exchanger characteristics, hydraulics for control valve design and selection, and have some structural engineering background (for control room and panelboard design).

### Small-Company Solution

How does the small company, with a limited number of engineering personnel, get this service? It can, of course, retain a competent consultant, or engineering, firm. This service, whether used *in toto*, or whether the outside personnel are interspersed in your own organizational group, should function under the *systems engineering* concept mentioned above.

A company might rely on the sales engineers from an instrument manufacturer to help out, but this is obviously a very limited service. The bigger instrument companies have application-engineering services; indeed they solicit all the instrument business for a project on a "package" basis — engineering services, procurement, and installation. This may be adequate for the processes that are relatively simple in

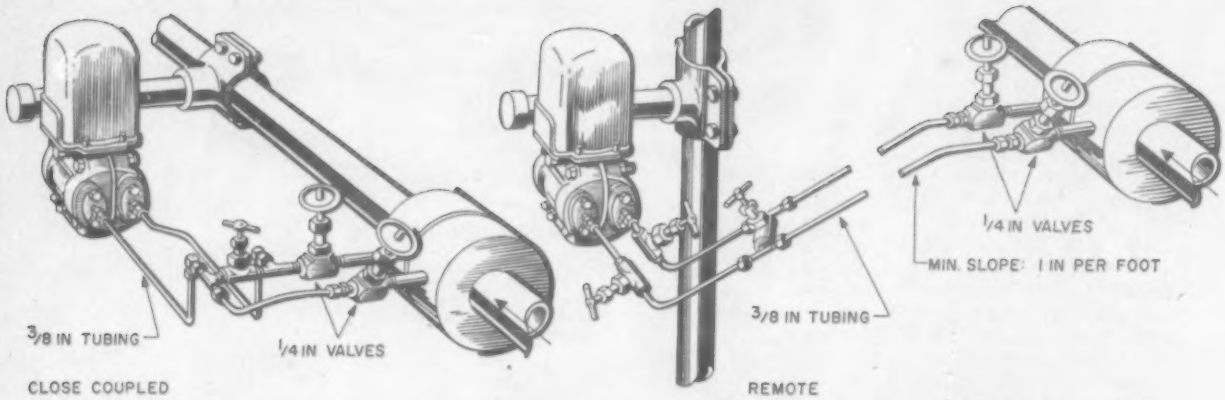



**Fig. 1. In designing, it is vital to choose correctly between alternate piping methods for differential-pressure transmitters**

operation and size, but definite limitations are inherent in this arrangement.

This group must participate in the design stage, or be told explicitly the significance of various parameters. They must be aware of equipment function and characteristics. Selection of the *method* of measurement and control is extremely important to the owner. The instrumentation market is at such a sharp competitive level that no one company can be pointed out as having the most complete and optimum line of devices — or even 50 per cent of the most commonly used instruments.

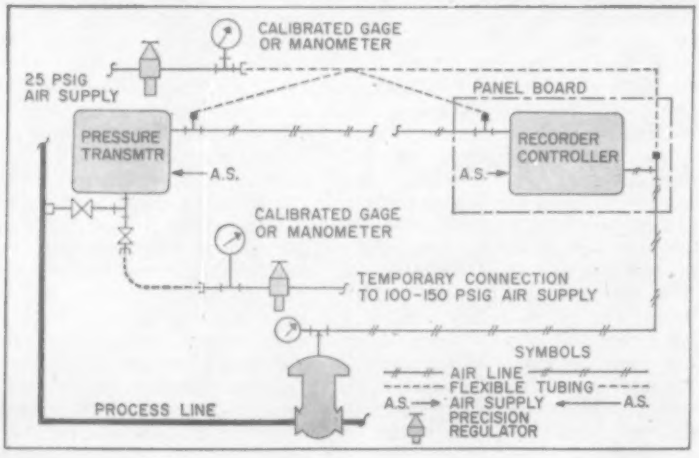
Engineering next enters the economic aspect by comparing the overall costs of the methods considered. In addition to design criteria of range, accuracy, sensitivity, etc, as mentioned above, additional consideration of power consumption, serviceability, complexity of calibration, and modular physical design of the component are also weighed. Then qualified manufacturers should be invited to bid on each component, or class of component. Qualification is by past performance of both the product and the manufacturer.

Evaluation and selection is no arbitrary thing. It takes experience and impartiality. Awarding all the instrumentation and controls to one vendor might result in an unnecessary premium in capital cost. The other extreme — spreading the instrument orders with as many vendors as are in the market — is just as unwise, with penalties of excessive spare parts, mechanic training costs, and lack of interchangeability. There is an obvious optimum between these extremes, and the systems engineer has a prime responsibility to find it.

Don't get the impression that it is a contention here that instrument application is too important to be left to the instrument manufacturer. Actually, the relationship between the instrument engineer and the instrument manufacturer is a mutual one. The manufacturer brings new designs and applications by other users to the systems engineer's attention; and he impresses the manufacturer with new design requirements, and is a good source of market information to the manufacturer.

It is axiomatic that any group, internal or external to your organization, selected for the engineering and design of a process, new plant, or modernization of an existing plant or process should have operating and maintenance experience. This will insure plant and equipment design layout most favorable to efficient maintenance.

**Fig. 2. Typical calibration and simulation for a pressure control loop**




## Design of the System

Maintenance begins with design; selection of the type and particular manufacturer is out of consideration of initial cost *and* maintainability of the equipment. This is further augmented in the design stage. Figure 1 is a typical consideration, showing alternate methods of piping a differential-pressure transmitter. It shows a close-coupled differential-pressure transmitter, and one located at an accessible elevation above grade.

There are reasons of response-speed versus process consideration, winterizing, insulation cost, etc that must be considered in each case. As a generality, *accessibility* is a major consideration. In fact, in any plant it is preferable to locate all the instruments at grade, or on service platforms.

Another example of optimization in design for maintenance is a method of protection of field-mounted instruments. A transparent plastic bag is used to keep a clean, dry atmosphere around the out-of-doors instruments, and still allows reading of the gages. Quite a bit of research has gone into this method.

Most satisfactory cover is a two-mil-thick, treated Mylar bag, originally developed by Pennsalt Corp, under supervision of Mr. Russel Cushing, Chief Instrument Engineer. It is a lower cost installation, com-

pared to a weather-proof instrument house, and just as effective. Note that the air supply piping is designed to accommodate this type of protection.

Besides accessibility and protection, instrument design also includes connections in the piping to allow *in-place* calibration and simulation of process dynamics by the imposing of known values of pressure (or weight) on control loop components and entire control loops. This allows field trouble-shooting with minimum down-time and shop time, and isolation of trouble location. Figure 2 shows a typical piping hook-up for calibration and trouble-shooting of the components of a pressure control loop.

### Maintenance of Instruments

A power engineer has one prime responsibility, the keeping of his plant in a profit-producing condition. Minimum down-time, and minimum maintenance costs, are the goals that fulfill this responsibility. Every dollar reduction in maintenance costs is the equivalent of 5 to 10 dollars from new sales in the company's profit picture. Maintenance costs run from 15 to 25 per cent of total direct manufacturing costs, on a national basis. Maintenance expenditures can total from 2 to 7 per cent of all plant capital expenditures.

One factor is the percentage of labor, as a portion of the total maintenance costs. This runs between 40 and 50 per cent of maintenance expenditures. This situation has led some contracting firms, such as ours, to enter the field with *contract maintenance*.

This also is an optimization concept: the use of skilled labor only when it is needed, with a skeletal supervisory force required on the part of the client. It has opened new vistas in maintenance planning. In the prior comments on selection, the attitude was developed that the engineering staff should control equipment and manufacturer selection; and, that whether the engineering group was *company* personnel or *outside* consulting help, the philosophy and function are the same.

However, in the maintenance aspect, I must depart from this operating company posture and describe maintenance programs for the maintenance contractor's position. Generally, contract maintenance is sold to a new plant as a total service, and instrument maintenance is just one sub-group in this over-all program.

Figure 3 shows a typical instrument group organization chart. The headquarters for the instrument supervisor is the instrument shop, where the majority of repair work takes place, as well as primary calibration. Maintenance planning actually takes place just before the start-up period of a plant. Here, the selection of the mechanic and the skilled craftsmen for instrument installation, calibration, and commissioning is part of the over-all service. The instrument organization is formed and starts functioning at this time.

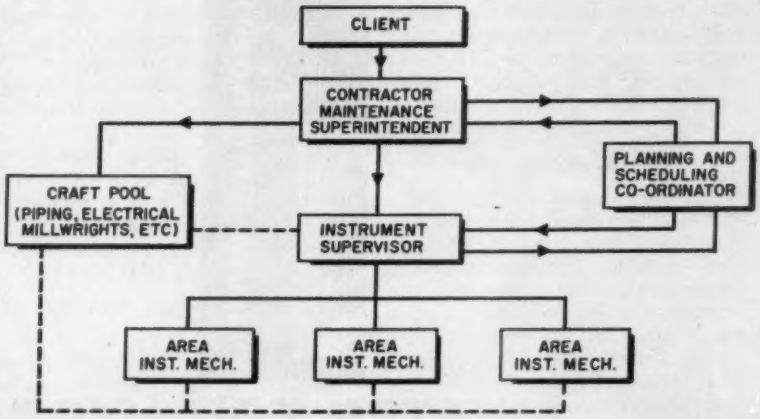



Fig. 3. Chart shows typical organization for contract instrument maintenance

The system of servicing used by us is called "telephone company service." The area mechanics can direct craftsmen from the labor pool to field assignments. They carry a few tools and make a few tests; then, if necessary, they install prechecked new components rather than fix them in the field. The malfunctioning component is returned to the shop for repairs and recalibration by skilled mechanics. Such procedures produce minimum disturbance to the plant, and minimum down-time.

More importantly, the field men need not be highly trained, well-rounded, skilled technicians. We have established trouble-shooting procedures from both our process operation experience, and in coöperation with the various manufacturers of instruments. We mention *process operation* because quite a few of the instruments that are charged with a malfunction are actually advising of an equipment or system malfunction, rather than an *instrument* failure.

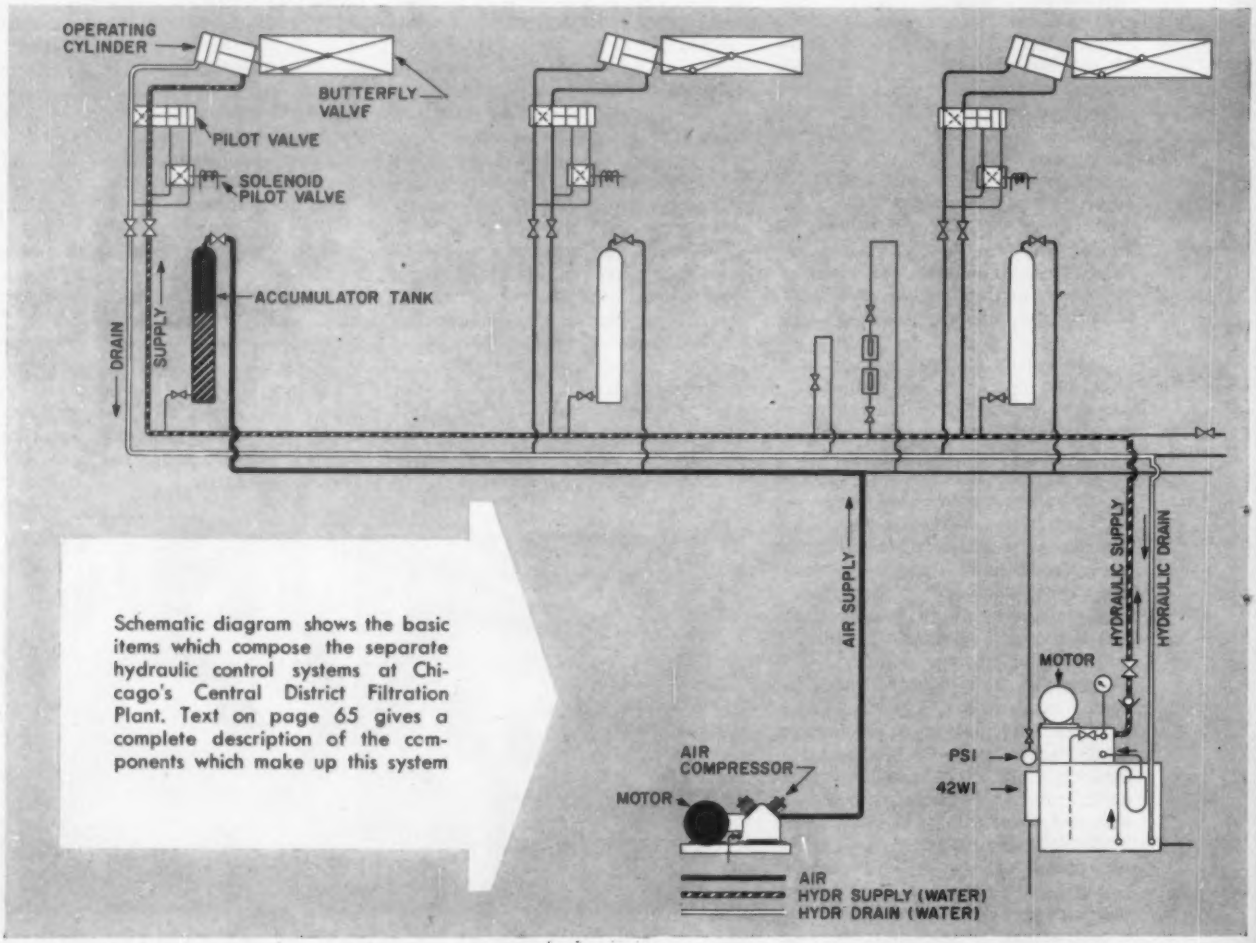
Too often, an operator will blame instrument operation, so we must instruct the field instrument men in trouble-shooting procedures to isolate the cause of trouble. From experience, it has been found that this system allows a ratio of *one good mechanic to adequately service and handle one hundred major instruments.*

Experience also shows us that emergency work in instrumentation is from 5 to 15 per cent of all maintenance work. We use this percentage to determine the quantity of spare units and components that are in a ready condition. Incidentally, modular design is a standard in the instrument industry. This is based on the above philosophy of quick replacement at the site and overhaul at a more leisurely pace back in the instrument shop. THE END

Fig. 4. Plastic bags are used to protect the field-mounted instruments

# WATER FOR HYDRAULIC CONTROL OF LARGE BUTTERFLY VALVES

## B. R. NICHOLS OF ALLIS-CHALMERS' HYDRAULIC DIVISION SHOWS HOW THIS SYSTEM WORKS – IN ONE OF COUNTRY'S LARGEST FILTRATION PLANTS




Schematic diagram shows the basic items which compose the separate hydraulic control systems at Chicago's Central District Filtration Plant. Text on page 65 gives a complete description of the components which make up this system

CHICAGO'S NEW $100,000,000 Central District Filtration Plant, located north of Navy Pier, will obtain water from Lake Michigan through six 260-MGD and two 170-MGD centrifugal pumps, with provision for two additional 170-MGD pumps.

Pumps will be arranged in two groups, each containing three of the larger pumps and one of the smaller pumps. Butterfly valves, connected to the pump discharge flange, and high-pressure hydraulic systems (for operation of the butterfly valves) add necessary control.

Butterfly valve hydraulic control systems employ an interesting design for this size equipment; *water* is used in place of the normal special hydraulic fluids. The valves connected to the 260-MGD pumps are 108-in.-diameter AWWA rubber seat, bubble-tight design, and those connected to the 170-MGD pumps are of the same design but with a 90-in. inside diameter.

### Hydraulic Fluid

Water at 100 psig, containing approximately 5 per cent soluble oil, will be used for the hydraulic fluid in the valve control system. The soluble oil will provide sufficient lubrication for valves, pumps rams, etc. The practice of using water as an operating fluid dates back to the first hydraulic control systems; however, this practice was later followed by the use of oil, except in very large systems.

Danger of fire or explosion from flammable oil vapor, escaping from leaks, prompted the development of the so-called non-flammable oils for use in high-pressure hydraulic control systems.

This type of oil is expensive, and may account for relatively large initial cost (and maintenance) of a hydraulic control system. In water works projects, the useful life of the equipment is expected to extend over many years.

### Separate Control Systems

When safety of personnel, and cost of non-flammable hydraulic oil, were compared to water, the design engineers elected to use water as an operating fluid in the control system.

Each of the two groups of butterfly valves is serviced by a separate hydraulic control system, made up of the following basic items illustrated in the schematic diagram, opposite:

(a) Four Accumulators, of the simple bottle-type, operating with approximately ⅓ water and ⅔ air, at 1000 psig; (b) two triplex reciprocating pumps, rated at 5 gpm, 1200-psi discharge pressure. Each pump is driven by a 7.5-hp induction motor; and (c) one four-cylinder air compressor, rated 13 cfm at 1200-psig discharge pressure, and 7.5-hp motor.

Air header and water-pressure header are connected through a liquid-level sight gage so that maximum and minimum liquid level, within the accumulators, may be easily observed for proper operation.

A bleeder-valve connection (between the water-pressure header and water-drain header) is located near the liquid-level sight gages and compressor start-stop push button, for convenience in adjusting the liquid level in the accumulators.

### Other Operations

Each of the butterfly valves is equipped with hydraulic cylinders controlled through a solenoid-operated valve. Isolating valves are provided throughout the control system, so that any single piece of equipment may be isolated for maintenance (or inspection) without disturbing the remainder of the equipment. The air compressor motor control and high-pressure pump motor control circuits are of conventional design.

Under normal operating conditions, the centrifugal pumps will be started with the water depressed below the impeller. A speed switch, operated by the centrifugal pump motor, will close the butterfly valve open circuit when the speed is near normal.

In shutting down the pump, the butterfly valve will start closing against full pump discharge. When the valve has closed to a position which will cause the motor load to increase to 125 per cent of rated motor load, the motor will be tripped out and the valve will continue to close. A power-failure relay will initiate closure of all valves, in each group of pumps and valves, in the event of power failure to the pump motors. THE END

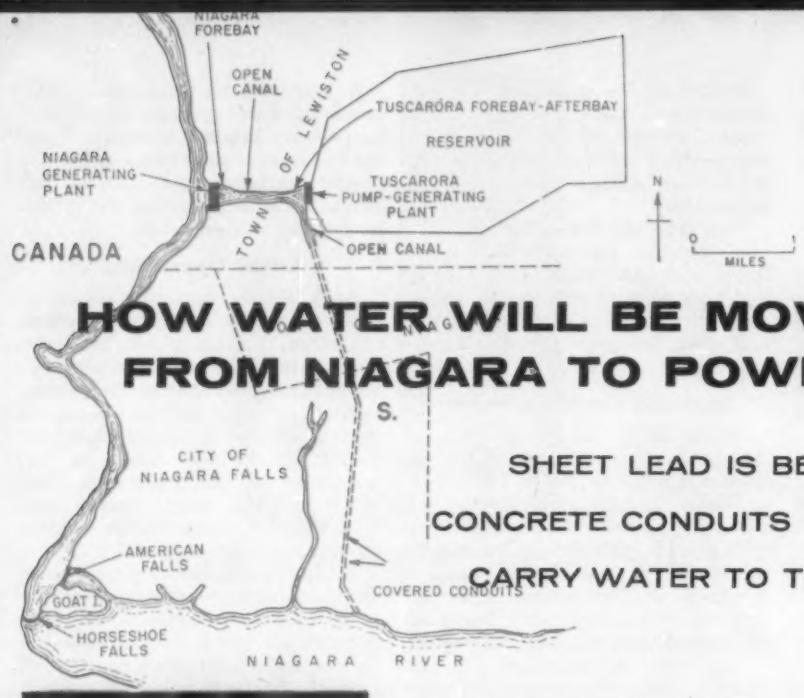
# EDITOR McCAW FLIES TO WPC and CIGRE

ROBERT F. McCAW, editor of POWER ENGINEERING, accompanied by Mrs. McCaw, flew TWA Flight 90 from O'Hare Field, Chicago, on June 2 to attend two important power meetings in Europe. Those were the World Power Conference, held in Madrid, Spain, June 4 to 9, and the meeting of CIGRE (International Conference on Large Electric Systems) held in Paris, France, June 15 to 25.

General theme of the World Power Conference was Methods for Solving Power Shortage Problems. Numerous papers were prepared by engineers from every country in the world, were summarized by a reporter at each session, and then discussed in detail by the delegates. These papers covered detailed studies of fossil fuel resources, hydroelectric resources, and other energy sources such as nuclear energy, solar energy and tidal power, in many countries of the world. Technical highlights of these papers will be summarized in a future issue.

Following the WPC meeting, the McCaws took a short post-conference tour, visiting Spanish power plants. Thence they flew to Paris.

CIGRE meeting is concerned primarily with the electrical problems of power systems. Here, again, as at WPC, papers were prepared by electrical engineers from every country, summarized and discussed. They covered technical details of electric generators, transformers, circuit breakers, high-voltage cables, insulators, relaying, power system planning and operation, extra-high-voltage transmission (380 kv and above). These details also will be presented in a future issue.




# HOW WATER WILL BE MOVED 4 MILES FROM NIAGARA TO POWER PROJECT

## SHEET LEAD IS BEING USED TO SEAL CONCRETE CONDUITS THAT WILL CARRY WATER TO TUSCARORA PLANT

Fig. 1. Construction view of conduit being formed in 100-ft-deep ditches

INTAKE for the $720 million Niagara Power Project (see map) will be at a point above Niagara Falls where surface of the river is at a mean elevation of 563 ft abóve sea level. Mean elevation at the tailrace below the main Niagara generating plant is 250 ft.

Water will be taken off from the river through two 700-ft-long reinforced concrete structures, tops of which will range in depth between 13 and 26 ft below the river level at this point. From each of these structures, the water will be moved through a vertical lift gate, 49 ft wide and 68 ft high, then released into one of two concrete conduits placed parallel below ground.

Each conduit will be 66 ft high, 46 ft wide, and 22,000 ft long, and will be capped by a three-hinged arch concrete roof. Tops of conduits will be on the average 40 ft below ground level. Slope will be about ¾-in. per 100 ft for most of each run. Water will lose about 11 ft in elevation here.

Massive sections of the walls of the concrete conduits are being poured at each stop of a mobile scaffold. Joints formed by the wall sections and the concrete base are sealed with sheet lead to ensure that they are water-tight (Figs. 2, 3, 4). The lead also serves as a lubricant to take up any stress induced by differential movement of the members.

The diverted water will emerge into an open canal, then flow into an open body of water, the eastern bay of which will serve as both forebay and afterbay for the Tuscarora plant, its function dependent on whether the plant is operating as pumping station or generating plant.

All the diverted water will finally be cascaded through the main Niagara generating plant, where the water will give up a head of 305 ft to produce 2.6 million hp. THE END

Fig. 2. Asphalt emulsion prepares strip to receive lead gasket for base of wall

Fig. 3. 40-ft rolls of sheet lead, 24 in. wide, are cut into 10-ft lengths

Fig. 4. Second layer of asphalt goes over lead, then concrete wall is poured

COMPLETING A SERIES OF ARTICLES ON COMPRESSED AIR FOR THE POWER FIELD, THIS ONE PRESENTS NECESSARY DATA, AND TELLS . . .

# HOW TO DISTRIBUTE COMPRESSED AIR

CAPACITY of the compressed-air distribution system depends on the amount of air to be used, plus an adequate additional capacity for the expansion of existing facilities, to compensate for the possibility of leaks and wear, and to add additional pneumatic tools and devices in existing facilities. The quantity of air needed to fill any given requirement depends on the total air consumed by pneumatic tools, air-powered machinery, and other devices.

When air is supplied for one continuously operating unit with a steady demand, the amount of air needed is relatively easy to determine, and the margin for wear, leaks, etc is no great problem. On the other hand (and it is the more frequent type of case), the air requirement must be based on the needs of a wide variety of tools and equipment. The amount of air needed in this case can only be approximated, but can be accomplished with reasonable limits, so that the estimated requirement need not greatly exceed the actual requirement.

Operating air pressure in the distribution system may vary from as low as 40 psi, to perhaps 250 psi — for a diesel engine starting device. The approximate pressure requirements of some commonly used equipment is given in Table I. Because of differences in manufacturing techniques and tolerances, and because of the widely differing operating conditions, the figures in the table should be viewed only as approximations.

### Design of the System

An air distribution system is generally considered to encompass the main pipeline, headers, and the hoses to tools and devices — omitting the components that dry, store, lubricate, filter, or regulate the air.

Before the size and location of the piping can be established, the amount of air required in any given location must be determined as accurately as possible. In laying out the area, one of two systems is generally used: 1. the loop *centralized* system shown in Fig. 1, or 2. the loop *decentralized* system shown in Fig. 2. Each system has advantages, and the choice between them usually devolves upon such matters as the kind of operation involved and factors of economy.

### Design Should Be Correct

A poorly designed distribution system can result in ineffective operations that usually result in needless waste of money and loss of production. In Fig. 1, the pipeline forms a loop around the entire work area, outlets are provided for each individual work area, and a single compressor (and one receiver) are sufficient to meet air requirements.

In Fig. 2, however, while the loop system is used, air requirements are such that the individual work areas are supplied primarily from their own compressor-receiver systems. By the use of the valves, air can be diverted and used to meet special needs. Loop systems are highly desirable because they make available a two-way distribution to that point which has the greatest need for air.

The following will serve as a guide in laying out a distribution system between the air compressor and the point of use:

**A.** Pipe sizes should be so selected that power-drop between the receiver and the point of use does not exceed 10 per cent of initial pressure. Reasonable future growth, as well as current needs, should be borne in mind when making this decision.

**B.** Frequent outlets should be provided for the attachment of air-operated equipment, so as to minimize pressure-drop in hoses. Outlets should be placed at the top of the pipe to avoid carryover of condensed moisture to the equipment.

**C.** A loop system should be utilized so as to provide two-way distribution where demand is the greatest.

**D.** If an aftercooler is not installed — and as a further safety measure if it is — piping should be arranged sloping toward a trap, so that condensed moisture may be prevented from entering air tools and other air-operated devices.

**Table I—Pressure Requirements**

| Pneumatic Tool or Device | Pressure Range (psi) | Air Consumed (cfm) |
|---|---|---|
| Heavy-duty paint sprayer | 70–100 | 15–30 |
| Light-duty paint sprayer | 40–100 | 1–4 |
| Air hoist (1 ton) | 80–100 | 3–4 |
| Sand blasters | | |
| ¼ blaster nozzle, 8 mesh | 80–100 | 90 |
| ½ blaster nozzle, 5 mesh | 80–100 | 350 |
| Heavy-duty grinder (8 in.) | 80–100 | 35 |
| Heavy-duty hammer | 70–90 | 30 |
| Light-duty laundry press | 70–80 | 1 |
| Drill (⅞ in.) | 80–100 | 30 |

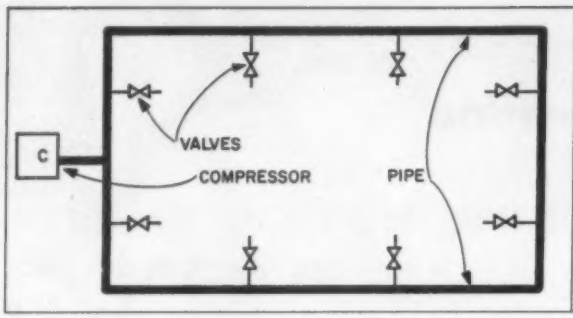



Fig. 1. Diagram of centralized loop air distribution system

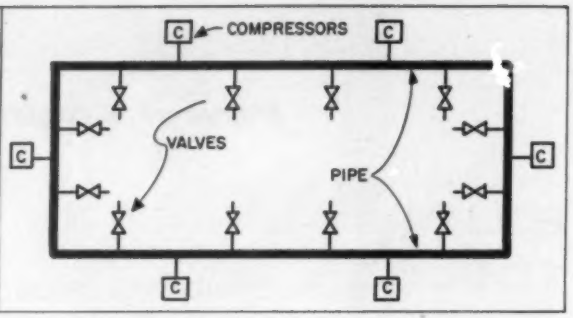



Fig. 2. Diagram of decentralized loop distribution system

E. Large-capacity receivers should be located at the extreme ends of long distribution lines, and at points of heavy demand, in order to avoid excessive pressure drops in the system.

F. Use of oversize piping costs but little more than a smaller size, and will pay for itself many times over, particularly if the system is to be expanded later.

G. Low pressure at the point of use is costly and decreases production. Pipe and hose lines can, and should, be kept tight and leakproof. Lines should be as short and straight as possible.

Piping begins at the compressor. If the compressor discharge line is long, it is a good idea to *increase the pipe one size every 100 feet from the compressor*. It is important to make piping as direct and as short as possible. When bends are necessary, long-radius elbows should be used to reduce air friction, which is always a factor to consider even in straight pipes.

Table II gives data on the loss of pressure in pipes. The loss figures are in psi per 1000 feet of pipe. Piping should be well, and evenly, supported and anchored so as to avoid vibration, and special care should be used in this regard if overhead piping is used.

### Recommended Pipe Sizes

Pipe sizes recommended for air at 80–125 psig are shown in Table III, with the pipe diameter given in inches in the table. It will be noted that, if a pipe length is from 500 to 100 feet, and delivers 100–200 cfm of air, the pipe diameter recommended is two inches. Assuming adequate compressor capacity and negligible leakage, low air pressure may be presumed to result from inadequate piping.

It will be found that power loss varies approximately as the square of the air's velocity. Therefore, if we increase the pipe size, the velocity of the air will decrease and the power loss will decrease as a squared function — a considerable savings. Since labor cost is the most important factor in installing pipe, the installation cost for, say, a 4-in. pipe would be only slightly greater than that for a 3-in. pipe, and the danger of inadequate piping and power loss would be obviated.

Main pipeline should be installed so condensation will drain back into

**Table II—Pipe Pressure Friction Loss**

| Pipe Size (in.) | Consumption (cfm) | Loss/1000 ft (psi) |
|---|---|---|
| 2 | 250 | 4.8 |
| | 500 | 19.2 |
| 3 | 1000 | 9.3 |
| | 1500 | 21.0 |
| 4 | 1500 | 4.9 |
| | 2000 | 8.8 |

**Table III—Pipe Sizes**

| Air Flow (cfm) | Pipe Length (ft) 50–200 | 500–1000 | 2500–5000 |
|---|---|---|---|
| 30–60 | 1 | 1.25 | 1.5 |
| 100–200 | 1.25 | 2.0 | 2.5 |
| 500–1000 | 2.5 | 3.5 | 4.5 |
| 2000–4000 | 3.5 | 6.0 | 8.0 |

**Table IV—Hose Pressure Friction Loss**

| Hose Size (in.) | Consumption (cfm) | Loss/50 ft (psi) |
|---|---|---|
| 0.50 | 40 | 6.0 |
| 0.50 | 80 | 34.6 |
| 0.75 | 40 | 0.8 |
| 0.75 | 80 | 3.6 |
| 1.0 | 40 | 0.2 |
| 1.0 | 80 | 0.8 |

Note: Line gage pressure 80 psi, coupling at each hose end.

**Table V—Hose Sizes**

| Air Flow (cfm) | Hose Length (ft) 0–25 | 25–50 | 50–200 |
|---|---|---|---|
| 0–15 | ¼ | ⅜ | ½ |
| 15–30 | ⅜ | ½ | ½ |
| 30–60 | ½ | ¾ | ¾ |
| 60–100 | ¾ | ¾ | 1 |
| 100–200 | 1 | 1 | 1¼ |

**Table VI—Approximate Leak Costs**

| | Opening (in.) | | |
|---|---|---|---|
| | 1/16 | 1/8 | 1/4 |
| Air Lost* (cu ft/mo) | 182,000 | 740,000 | 2,921,000 |
| Air Cost** (in dollars) | 13 | 52 | 204 |

* 100 psig with nozzle coefficient of 0.65
** At $0.07 per 1000 cu ft

the air tank, and branch lines should be taken from the top of the main pipeline to aid in preventing water droplets from entering the rest of the system.

As in the case of pipelines, the friction loss in *hoses* may not be neglected in the air distribution system. Table IV gives the pressure loss in psi for a 50-ft length of hose with a smooth inside lining. Hoses with rough interiors may have losses 50 per cent greater than those given in the table.

Table V shows recommended hose sizes for tools and devices that use air at 80–125 psig. As shown in the table, a hose that is one inch in diameter should be used for a hose length of 50–200 feet, if carrying 50–100 cfm.

Pneumatic hose comes in a variety of materials and capabilities. A new hose of Teflon is suitable for 6000-psi pneumatic services, and 24,000-psi burst pressure, in areas where very high charging-pressure, vibration resistance, and resistance to high temperature are required. Such sturdy hose is not required, of course, in the usual distribution system.

### Pressure and Cost

Manufacturers of pneumatic hand tools and air-actuated equipment normally specify an *optimum* working pressure. Operating above that recommended pressure shortens the life of the tool or device, and operation below it will decrease production. It is therefore important that air pressure at the work point be checked and regulated accordingly.

Production costs are strongly affected by air pressure which, in turn, is determined by the effectiveness of the air distribution system. The maximum output of most pneumatic tools require that an ample supply of compressed air, at the correct pressure (usually 90 psig), be available at the tool, so that the tool's capabilities may be realized.

Personnel must be aware that the pressure at any point in the system, other than at the tool itself while it is in operation, is not the criterion. It may be that compressor pressure is 90 psi but, if only a 60-lb pressure is available at the tool, a loss in production of from 25 to 60 per cent can result. If such a condition exists, an immediate check must be made of pipes, valves, fittings, and air hose to determine whether proper size of pipe is used, size and length of hose are satisfactory, or obstructions exist.

Significance of an adequate supply of compressed air for a pneumatic tool, in attaining maximum tool efficiency is illustrated by the following example:

Assuming labor and overhead costs of $6 per hour, and with five men operating pneumatic tools during an 8-hr day, the cost will be $240 ($6 × 5 × 8) per day. If correction of an inadequate air supply results in a 10 per cent increase in production, the savings will be $24 (10 per cent of $240).

If the five tools average an air consumption of 30 cfm with an inadequate supply, and assuming that correction of the deficiency results in a rate of 40 cfm and full power, an additional 50 cfm (10 × 5) would be used.

Presuming tool use of one-half of the time, the actual expenditure of air would be 25 cfm (50 cfm × 50 per cent), or 1500 cu ft per hr. At $0.06 per 1000 cu ft, the additional air would cost $0.09 per hr, or $0.72 per day.

A comparison of the daily air cost ($0.72) with the production savings ($24) per day shows an obvious decrease in production costs.

### Maintenance of System

If reasonable maintenance of compressed-air systems is not conducted at regular and frequent intervals, a drop in production, together with its consequent dollar loss, is to be expected. If air power decreases, insufficient compressor capacity may be suspected, when the real fault lies in the distribution system.

Periodic (weekly) checks of the system for leaks are a relatively quick and easy matter, with results in preventive maintenance far exceeding the time and effort expended. The most likely places to check for leaks are around valves, hose connections, lines to tools and other operating media, drains, unions, and other fittings. Table VI lists approximate leak costs.

Methods of checking for correct operating pressures and leaks include use of a hypodermic needle gage inserted in the line at its operating end while the tool or other medium is in use, introduction of a pungent substance into the air system, brushing of soapy water on suspicious areas, and the use of lighted candles or small torches.

A survey of a compressed-air installation should be systematic in nature. It should begin with the air being fed to the compressor, pass through the compressor plant and its associated equipment, follow along all piping, and end with an examination of the compressed air at the various points of use.

Having discovered causes of waste and inefficiency by means of a survey, corrective measures are comparatively simple. And, having accomplished the correction of basic deficiencies, it is relatively easy — and very profitable — to institute preventive maintenance measures.

### Preventive Maintenance

*Corrective* maintenance may vary widely — from the instruction of an operator in the proper use of an air-powered tool to the realignment of pipes, replacement of leaky valves, and installation of alarms. *Preventive* maintenance of the compressed-air system, on the other hand, follows a fairly well-defined set of rules.

A frequently neglected part of the compressed-air system is the equipment associated with the operation of most compressors — filters, receivers, and aftercoolers. These items must not be overlooked entirely, even though they do not require extensive maintenance. Periodic checks will do much to insure optimum effectiveness of the system as a whole (see POWER ENGINEERING, May, 1960, p. 56). Filters, separators, and water traps should be cleaned and drained. If not already so installed, they should be placed close to the point of use to prevent condensation after filtration.

Fittings and hoses also have a strong effect on tool performance. If washers and valves are worn, they will restrict the passage of air and thus affect the tool's operating characteristics and its productivity. Although a quick-disconnect fitting and valve may result in a 3-psi drop (5 per cent in tool efficiency), its ease of inspection makes it especially desirable for an effective preventive maintenance program to eliminate compressed-air defects before they affect productivity. THE END

# VIBRATION IN ROTATING MACHINERY

## FORCES THAT CAUSE IT . . . MEASURING TOOLS THAT HELP TO ELIMINATE IT

S. R. PETERSEN, of the Large Rotating Apparatus Dept at Westinghouse, defines vibration as the cyclic movement of a body with respect to some reference. This cyclic motion is caused by an exciting force. Therefore, to eliminate or reduce vibration the following corrective action is taken: 1. remove or reduce the exciting force, 2. increase the resistance of the vibrating member to the effects of the exciting force. As Mr. Petersen has developed this subject for the benefit of POWER ENGINEERING readers:

Before the above steps are taken, one must know what exciting force is present. In electrical rotating equipment the exciting force may have its origin from an electrical or mechanical cause which can be located within or outside the machine.

Factors which will excite vibrations in electrical machines are, for *electrical exciting forces:* 1. unsymmetric magnetic pull due to an out-of-round rotor; 2. revolving magnetic field of the rotor on a synchronous-type a-c machine. Under this second factor these can be included: (a) normal force exerted on the stator due to distribution of poles around the rotor periphery; (b) unsymmetric magnetic pull due to unsymmetric winding of rotor, as for example when a coil is shorted in one of the field coils; (c) rotating magnetic fields in single-phase motors.

Under *mechanical exciting forces* there is: mass unbalance; journals out of round; coupling misalignment; uneven heating of shaft caused by rubbing on an adjacent part; uneven balls, rollers, or races in anti-friction bearings; vibrating foundation; pulsating torque; thermal unbalance; unequal moment of inertia of effective shaft; oil whip; bent shaft.

Most common type of vibration in a rotating machine is due to mass unbalance in the rotating member (or rotor). Parts of the rotor are therefore designed to be symmetrical about the shaft centerline so that the weight will be equally distributed around the axis of rotation. However, due to necessary shop tolerances and non-homogenous materials, this is not obtained. Therefore the rotor must be balanced.

### Static Unbalance

Type of balance and number of balancing operations performed during manufacture depend on the size, operating speed and flexibility of the rotor. Basically a rotating part has either a static or dynamic unbalance (Figs. 1 and 2).

Static unbalance is normally thought of as a one-plane unbalance which can be eliminated with one balance weight. Consider a thin disk mounted at right angles to the axial centerline of a shaft. If the center of gravity of the disk is not on the shaft centerline, then the assembly will vibrate when it is rotated, as shown in Fig. 1.

To correct this condition a static balance machine is used. This consists of two horizontal knife-edge pedestals. When the shaft rests on the knife edges, the heavy side of the disk will roll to the bottom. The part is balanced by either adding weight 180 degrees opposite the heavy spot or by removing weight on the heavy side. The unit is statically balanced when it will lie still on the knife edges in any angular position.

### Dynamic Balancing

Dynamic unbalance occurs during rotation of parts which have length along the axial centerline. This unbalance is caused by a moment effect due to the centrifugal forces of masses in different planes at right angles to the axis of rotation.

To illustrate this unbalance, consider a shaft with two thin disks spaced a distance $L$ apart and mounted at right-angles to the axial centerline, as illustrated in Fig. 2. Assume an unbalance weight $m_1$ in plane I at distance $r$ from the rotational centerline.

The assembly could be balanced statically as outlined above by placing a mass equal to $m_1$ in plane II at distance $r$ from the centerline rotated 180 degrees angularly from the unbalance. When the assembly rotates,

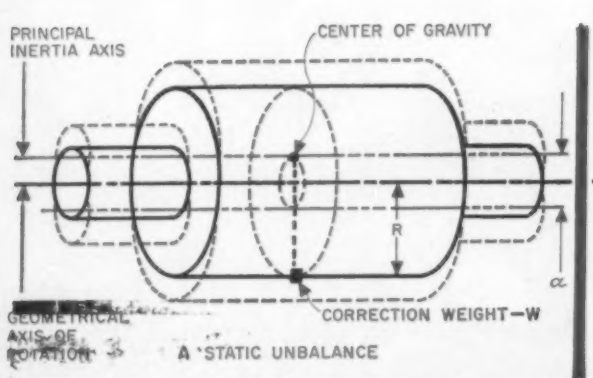



Fig. 1. One-plane static unbalance takes one weight

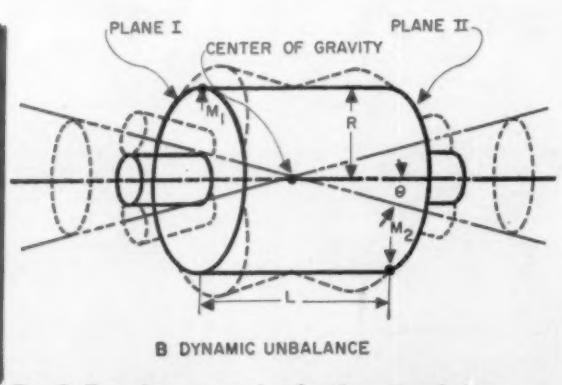
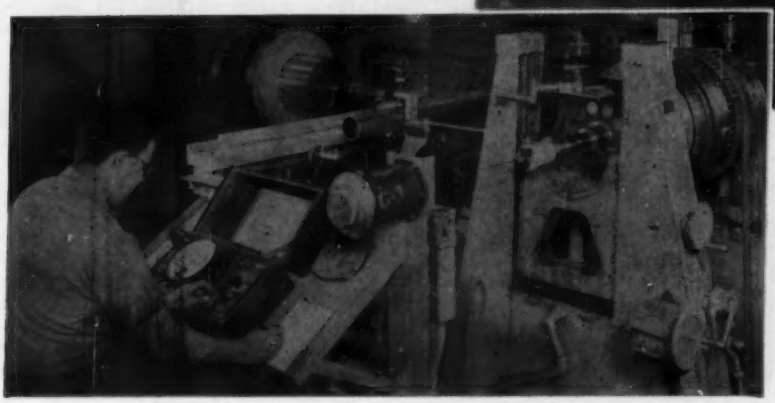



Fig. 2. Two-plane correction for dynamic unbalance

Figs. 3 and 4 are two types of dynamic balancing machines. Below is model-bar type using HQ-type portable balancing equipment. Right shows special high-speed machine for balancing 3600-rpm turbine-generator exciter rotors



a centrifugal force $mV^2rL$ will be exerted by each mass when $V$ is the angular velocity. This will cause a couple equal to $mV^2rL$, which will cause the ends to vibrate as shown in Fig. 2. This vibration could be eliminated by balancing each plane.

It can be proved that a rigid rotating part which has length along the rotational axis can be balanced in two separated planes, such as plane I and plane II. This correction can remove both the static and dynamic unbalances present.

There are various types of dynamic balancing machines. Such balancers are equipped with a drive mechanism to rotate the work piece, which is either directly coupled or driven with a belt. Speed of rotation varies depending on the machine but is normally lower than operating speed.

Bearings of a dynamic balancing machine are usually supported with freedom of motion in the horizontal direction. Natural frequency of the setup in the horizontal direction is well below the balancing-machine speed. A vibration pickup is connected to the movable bearing. The pickup used varies from dial indicators to electrical networks. By proper adjustment of the voltage divider, the unbalance indicator will show only the unbalance in the plane selected, and plane separation can be obtained.

Many devices have been invented to determine the angular position of the unbalance. These two types are most commonly used on dynamic balance equipment: a stroboscope light triggered by the unbalance which locates some mark on the revolving piece; angular location by use of a sine-wave generator, wattmeter and vibration pickups.

Dynamic balance machine shown in Fig. 3 is of the model-bar type using the Westinghouse HQ balance equipment. The HQ equipment utilizes the wattmeter principle (see below).

This article will not attempt to explain in detail all the various dynamic balancers available. It should be pointed out that various designs have been made to suit the particular application.

Figure 4 shows a special high-speed dynamic balancing machine for balancing 3600-rpm turbine-generator exciter rotors. This unit also uses the type-HQ portable balancer. Similar special balance machines are used for turbine-generator rotors. These machines are used only for special high-speed parts. It is difficult to maintain this special equipment for all the various sizes of rotors. There are definite advantages to performing the final balance with the rotor mounted in its frame on its own bearings. This can be accomplished by the use of portable balance equipment.

There is a variety of portable balancers which can be used for high-speed balance. Most common equipment used by Westinghouse is the

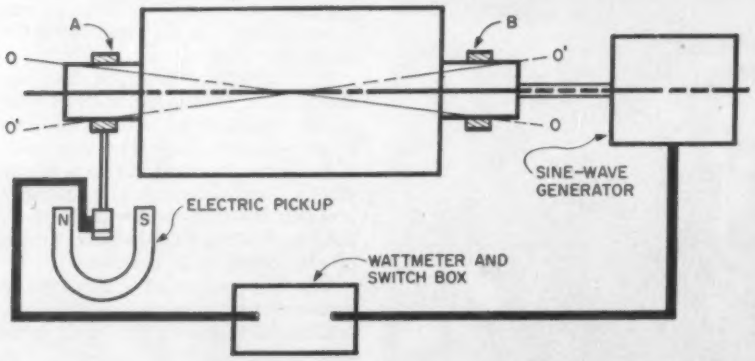
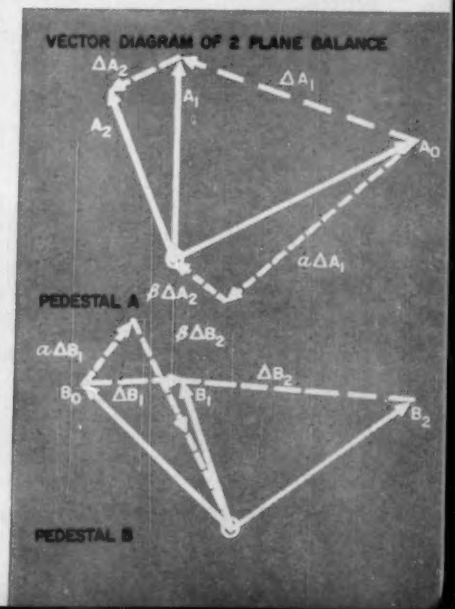



Fig. 5. Sine-wave generator rotor of HQ balancer is coupled to the machine rotor

Fig. 6. To obtain perfect balance, vectors $A_o$ and $B_o$ must be reduced to zero. When trial weight is rotated on rotor, the vector will then shift in same direction



type-HQ. Since this equipment is so extensively used for low- and high-speed dynamic balance and for field balance, it is well to examine briefly how it functions.

Figure 5 shows a schematic view of the various components of the HQ balance equipment. The sine-wave generator rotor is coupled directly to the machine rotor. Its output is fed into the current coil of the wattmeter. The pickup consists of a permanent magnet which produces a magnetic field across an air gap in which is located a movable coil.

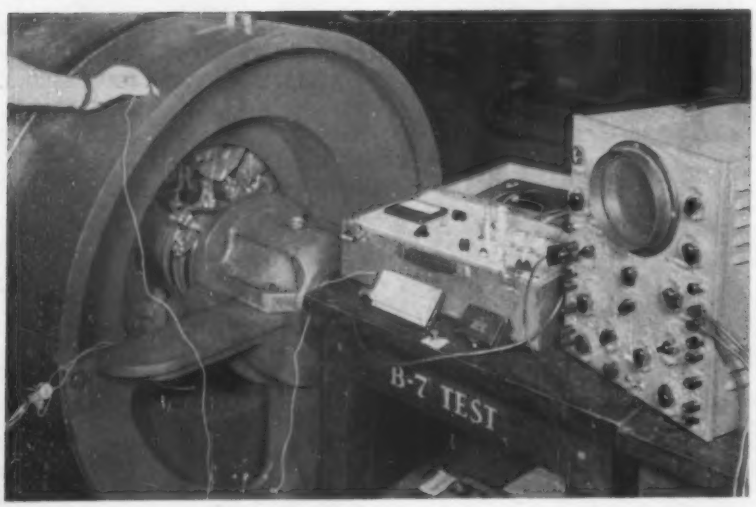
The movable coil is connected to the vibrating body by some mechanical linkage. As the body moves, it moves the coil in the magnetic field which, at a fixed frequency, generates a voltage proportional to the amplitude of vibration. This voltage is impressed across the voltage coil of the wattmeter. The wattmeter reading is proportional to the product of the voltage amplitudes of equal frequencies across its two coils multiplied by the cosine of the angle between them.

Since the sine-wave generator impresses a pure sine-wave voltage across the current coil, harmonic frequencies are filtered out. Therefore, the instrument reads only the amplitude of the rotational frequency.

Sine-wave generator has two identical stator windings 90 degrees apart. Stator can be revolved, and the case is equipped with a protractor for locating its angular position. By rotating the stator, the phase relation between the pickup voltage and current voltage is changed. When the cosine of this angle is equal to zero, a zero reading is recorded on the wattmeter. Then by switching to the other stator winding 90 degrees away, a maximum amplitude reading is obtained.

Angular location of the unbalance is read on the protractor mounted on the generator stator. Generator rotor also has a protractor. By correlating the readings between the two, the "high spot" on the rotor can be obtained.

Fig. 7 (left) shows three hand-held vibration-measuring instruments. Fig. 8 is system for frequencies 2–15,000 cps




### How HQ Balancer Works

Let us briefly examine how a unit can be dynamically balanced in two planes using this equipment.

The machine is run at rated speed. The pickup is mounted or held against each pedestal, and balance readings are taken of angle and amplitude of vibration. The readings are plotted as vectors on separate graphs for each pedestal. Let $A_o$ represent the initial vibration vector at Pedestal A, and $B_o$ the vibration at Pedestal B. (See the vector diagram in Fig. 6.)

Secondly, a known amount of weight is added at a known location to balance plane I. Readings are again taken and plotted as vectors $A_1$ and $B_1$. (Note: all angles are plotted counterclockwise from some reference line.)

Line $\Delta A_1$ connecting the ends of $A_o$ and $A_1$ gives the effect of the weight added in plane I, on pedestal A. Similar line $\Delta B_1$ gives the effect at pedestal B of the weight added in plane I.

A similar weight can then be added to plane II, and its effect on the vibration at pedestals A and B will be represented by $\Delta A_2$ and $\Delta B_2$.

To obtain perfect balance, vectors $A_o$ and $B_o$ must be reduced to zero. When a trial weight is rotated on the rotor, the vector will shift in the same direction. Therefore by changing trial weight one and two such that $\alpha\Delta A_1 + \beta\Delta A_2 = -A_o$, and $\alpha\Delta B_1 + \beta\Delta B_2 = -B_o$, balance will be obtained (where $\alpha$ is the angular position and weight change made in plane I, and $\beta$ is the same entity for plane II).

This same procedure is used on long flexible rotors. Since these machines usually have more than two balance planes, more than two readings are taken along the axis of the shaft. Consequently the balance problem becomes more difficult as the effect of the balance weight must be considered in all locations.

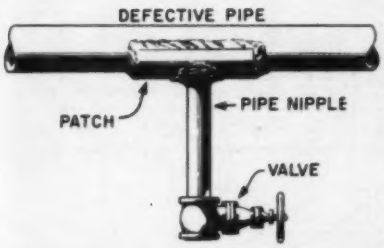
The HQ equipment is also used to measure the running-frequency vibration of related parts such as the stator, bearing brackets, etc. This equipment is used on all sizes of units.

*continued on page 76*

# HANDBOOK

Power Engineering

## Repairing Pipes Without Shutting Down




By HARRY J. MILLER

WHEN A PIPE springs a leak and repairs must be made even though shut-downs cannot be done at the time, we have our pipe welders make the repair with pressures on the line up to 1200 lb.

A patch is cut out of a piece of pipe and the welder lays an edge of about a ¼-in. around the patch. That is, the patch is made to fit the defective pipe so that the patch has a ¼-inch lip on the ID side.

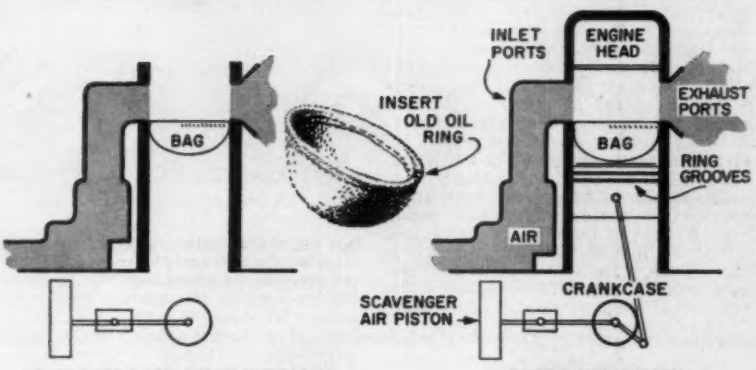
Then a hole is cut in the patch and a nipple carrying a valve is welded in. That way, the valve is opened to permit blow-off of the pressure while the patch is welded in place. After the repair is made, the valve is closed. At subsequent shut-down, valve is removed, so is the nipple, or the nipple is capped.

## Time-Saver In Cleaning a Diesel

By JERRY M. CAPPS

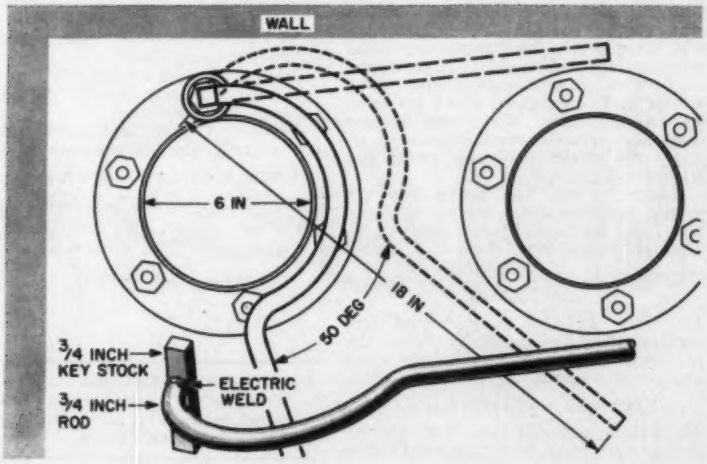
THIS BAG TRICK will save you time while cleaning the exhaust and inlet ports of a diesel engine. As shown, make a bag of heavy cloth, lap the cloth over at the top and sew, leaving an eye into which you can worm an old oil ring. You can then depress the ring and put the bag in the cylinder, thus saving the time of having to clean the crankcase.

It is not necessary to disassemble the engine. Bar piston down below the ports and insert the bag




## Making a Wrench That Turns 50 Deg

By VIRGIL L. PLOESSL




HERE'S A SKETCH of a wrench we made for use on those hard-to-reach pipe flange bolts. Original was made from a 20-in. piece of ¾-in. reinforcing rod and a 2¾-in. piece of ¾-in. key stock, and used with ¾-in. drive sockets.

By welding the handle to the center of the key stock, the socket will fit on either end of the key stock, making it possible to turn the wrench over so it can be used on either side of the pipe.

Note that it is possible to turn this wrench approximately 50 deg, while it would be almost impossible to move a straight-handled wrench of the same length.

This tool has saved a lot of time, temper and knuckles for us.

# Dispelling Water Vapor By Ventilation

By JOHN D. CONSTANCE, P.E.

VENTILATION, forced or natural, is necessary for certain parts of a building. During warm weather there is no question that building ventilation is almost essential to prevent heat build-up and to insure hot-weather comfort. In regions where winters are cold, ventilation is important not only for the summer comfort it provides, but also for the reduction in vapor pressure inside the building when it is applied. Purpose of this presentation is to show that higher humidities need to exhaust less air than at lower humidities, thus effecting a saving in heat.

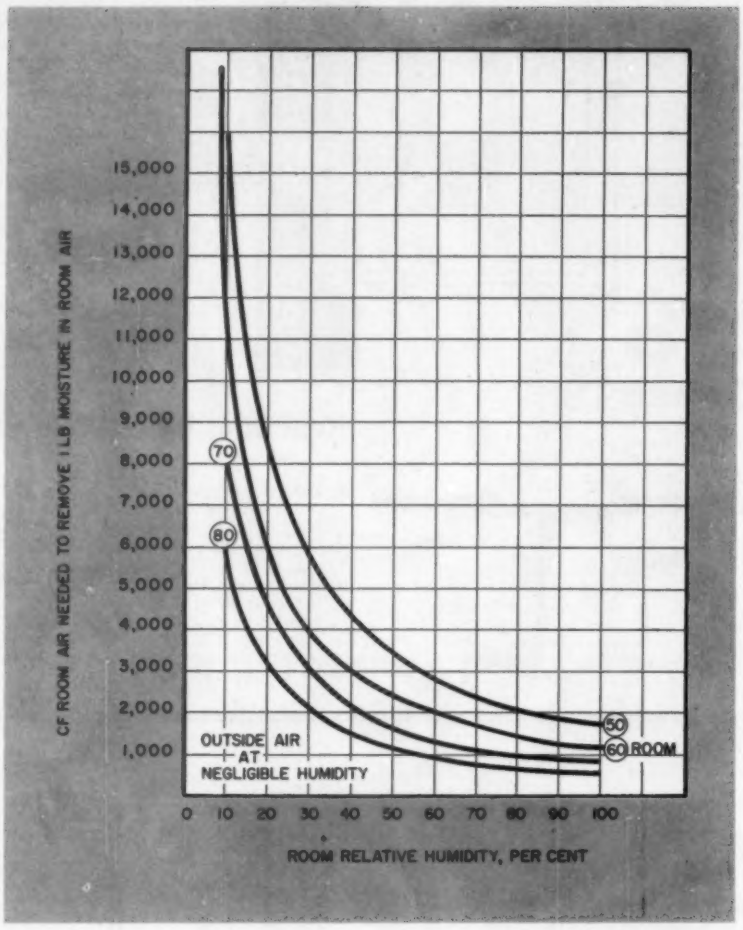
Older buildings with their rather unprotected airy structure do not present a problem from high humidities. Vapor pressure build-up here does not have a chance. However, the more modern buildings with insulation, double glazing, and vapor barriers do present a problem. Humidities tend to run high, especially where processes give off water vapor. Most attempts to protect the structure against high humidities have proved for the most part ineffective. Vapor barriers, vents in siding, or any attempt to ventilate the outer layers of the walls of a building have presented many drawbacks.

Ventilation from the interior outward by means of exhaust fans other than those used in the attic for summer comfort or industrial exhausters have proved both effective and economical if properly sized. Room air exhausted directly to the outside may be shown to be less wasteful of heat than one might imagine. Actually the rate of exhaust needed to dispel the water generated in a building is less when the humidity is high.

Graph shown here gives ventilation required to remove the water vapor generated in a building as being less when the indoor relative humidity is high. Thus, a room at 70 F and 30 per cent relative humidity needs only the removal of about 3000 cu ft of room air to carry away one pound of moisture in the form of water vapor.

On this basis, then, it costs less to ventilate an adequately insulated and moisture-protected (against high humidity) building than one not so adequately protected. Less air needs to be exhausted in order to dispel a given amount of moisture. As a result, if less air is removed, less heat will also be removed as a result when higher humidities are encountered. Also build-up of higher than desired humidities may be prevented by an intelligently designed exhaust system.

From the standpoint of construction what does this mean? The structure must be built or revamped so that it can withstand higher humidities ranging from between 40 and 45 per cent. Except for process considerations this is about the level which the average person requires for comfort and good health. This is quite higher than would exist in unprotected buildings.




To show how the graph may be used, here are a few examples:

*Example:* A building has a volume of 30,000 cu ft and an air infiltration rate of two air changes per hour. Average temperature inside is 70 F and 30 per cent relative humidity with outside at 0 F. What will be the moisture removal potential? The building is then protected with storm sash, insulation, and vapor barrier and maintained at 45 per cent relative humidity. What will be the necessary exhaust ventilation rate to dispel the water removable under the original conditions?

*Answer.* From the graph the air needed to remove one pound of water under the first condition is 3000 cu ft. Then the water removal rate is

$(30{,}000 \times 2)/(3{,}000) = 20$ lb per hour moisture removal potential.

After the building is protected and maintained at the higher humidity, the new ventilation rate to remove the same amount of water is

$2{,}000 \times 20 = 40{,}000$ cu ft per hr.

The rate is reduced from 2 to $1\frac{1}{3}$ air changes per hour. Now, the ventilation heat losses would be for both conditions

Unprotected building: $30{,}000 \times 2/60 \times 1.08 \times (70-0) = 76{,}000$ Btu per hr.

Protected building: $40{,}000/60 \times 1.08 \times (70-0) = 50{,}652$ Btu per hr.

*Example:* A process is liberating 100 lb per hr of water vapor into a room having a cubage of 10,000 cu ft. An existing vapor exhaust system is capable of removing 3,000 cfm of room air while maintaining room relative humidity of 25 per cent and a dry bulb temperature of 60 F. Determine what changes in the exhaust system (if any) must be made if it is desired to maintain 70 F and 50 per cent relative humidity during extremely cold weather.

*Answer.* The water removal rate of the existing exhaust system is

$3{,}000 \times 60/4{,}800 = 37.5$ lb per hr.

At 70 F and 50 per cent relative humidity

$3{,}000 \times 60/1{,}700 = 106$ lb per hour.

No change is necessary.

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# Performing Polarity Test On Transformers

By PAUL C. ZIEMKE

THERE SEEM to be as many types of tests as there are transformers, some of them quite involved, too; yet here is one this writer likes and has found effective.

Transformer B was purchased from a used equipment lot and its polarity is additive. It is to be used in conjunction with transformer A whose polarity is not established. We proceed by connecting the neutral of B to the line neutral; next the connection is made to the primary by the usual method. These are to be permanent ties, since no changes will be made here. Use a 300-v scale instrument if one is at hand; otherwise improvise with a 230-v lamp, to test between either of the outer lines and one transformer terminal, as indicated in the sketch.

Should no current be indicated, or a limited quantity, the secondary connection is made by hooking X1 to point 2 and X4 to point 1. Thus polarities may prove unmatched in comparison to the lead connections and we double the voltage, or 230 volts, on the voltmeter or lamp. This being the case, the secondary leads are reversed, or X4 to 2 and X1 to 1.

The above sequence of connections makes a safe test, since we have grounded the neutral to protect us in the event the insulation proved defective between the energized secondary lead and the energized transformer secondary terminal. A high reading on the voltmeter, or a bright lamp, indicates that these connections are not to be made.

To attempt the connection of unknown transformers, where opposed polarities are possible, can result in a damaging short circuit. Lacking either voltmeter or lamp in an emergency trial, connections should be lightly temporary with light fuse wire inserted in series to open safely in the event of wrong connections.

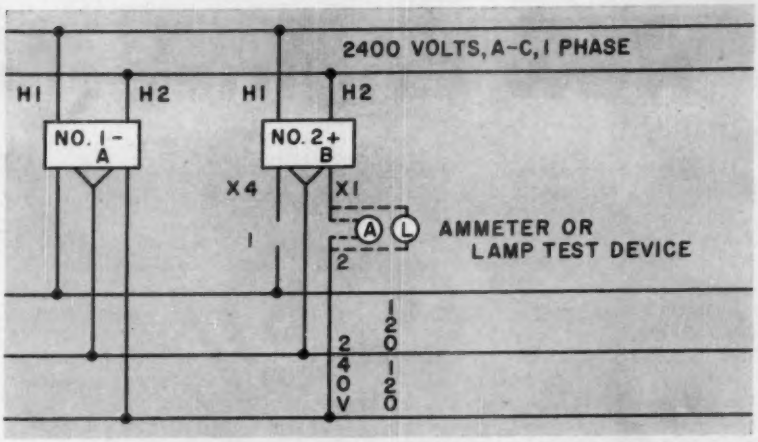



Fig. 1. Neutral of B is connected to the line neutral, then connection to primary is made in usual way

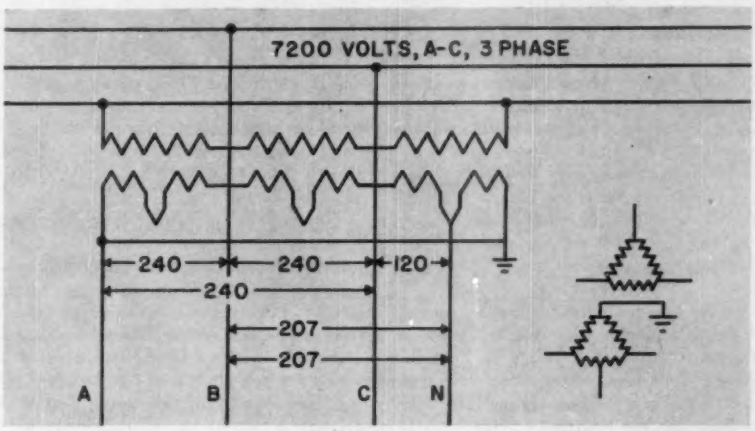
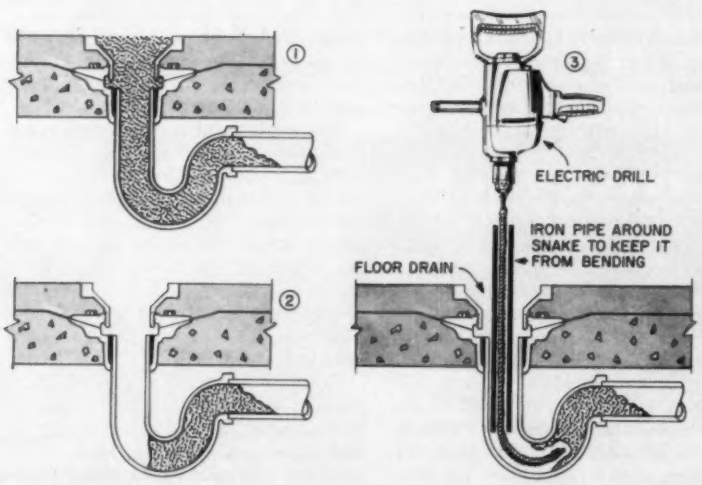



Fig. 2. Here the transformers are hooked up Delta-Delta. Conductors A-B-C develop 3-phase, 240-v, 3 wire; conductors A-N-C, 1-phase, 240-120-v, 3 wire for lighting service, and 207 v for appliances

Figure 2 illustrates a hook-up to produce 240-v, 3-phase, conductors A-N-C, 1 phase, 240-120-v, 3 wire for lighting and 207-v for special equipment.




# How to Drill Around a Corner

by N. R. SMALL, P.E.

PROBLEM is a floor drain full of magnesite (plastic stone) floor topping (1). How to clear the drain fully? Magnesite has been drilled out as much as seems possible (2).

Solution is an electric drill attached to a spring steel plumber's snake cut off at sharp angle (3). Thrashing sharp end easily digs out magnesite. Method should even work with green concrete.

Power Engineering HANDBOOK

# New Engineering Books

**Centrifugal Pump Application Manual,** edited by Bruce W. Ellis; 279 pages, 4¼ by 7 in. Published by Buffalo Pumps Div of Buffalo Forge Co, Buffalo, N. Y. Price, $5.

This soft-cover guide has been specially prepared to aid users of centrifugal pumping equipment to understand thoroughly all forms and types of equipment and to aid in selecting pumping equipment intelligently.

The study should help to clarify a few of the questions concerning centrifugal pump application and operation in many industries. Nomenclature, applications, pump terms, conversion factors and formulae, and friction losses lay a broad background from which the user can draw basic principles in order to gain a complete comprehension of more-detailed points. Specific industries, whose use of centrifugal pumping apparatus is quite extensive, are given individualized treatment.

Pump installation and testing, as well as pump troubles and their remedies, are explained in full scope. Forty-eight illustrations further clarify design, installation, and operation considerations.

★ ★ ★

**Fluid Power Control,** edited by John F. Blackburn, Gerhard Reethof, and J. Lowen Shearer; 710 pages, 6 by 9¼ in. Published jointly by Technology Press of Massachusetts Institute of Technology and John Wiley & Sons, Inc, 440 Fourth Ave, New York 16, N. Y. Price, $17.50.

Presenting the fundamentals of the operation of power-control systems whose working media may be either liquids or gases is the main purpose of this new treatise. Four major sections analyze fluid properties and fluid mechanics; theory and practice of hydraulic control components, with emphasis on control valves; and recent progress using gaseous working fluids, especially high-pressure pneumatics, with concepts of system analysis and design.

This study is primarily the product of the Dynamic Analysis and Control Laboratory of MIT, which worked coördinately with teaching of design and control courses in the mechanical engineering department. Both the staff and students performed the research and developed the framework on which this study is built.

DACL recognized the need for a study of this nature, for presently the limited books on this topic are mainly or completely descriptive.

★ ★ ★

**Hydromagnetic Channel Flows,** by Lawson P. Harris; 90 pages, monographed, 6 by 9¼ in. Published jointly by Technology Press of Massachusetts Institute of Technology and John Wiley & Sons, Inc, 440 Fourth Ave, New York 16, N. Y. Price, $2.75.

This book analyzes three flows of viscous, incompressible, electrically-conducting fluids in high-aspect-ratio rectangular channels subjected to transverse magnetic fields. Recent interest and scientific developments in the field of magnetohydrodynamics (MHD) have helped bring about this study, whose results include a scheme for correlating experimental friction-factor data and methods for computing mean-velocity profiles, mean magnetic-field distortion, current distributions, and turbulent-shear distributions in the d-c turbulent flow.

Curves for a wide range of operating conditions relate velocity profiles, current distributions, and turbulent-shear distributions.

Mr. Harris is currently an electrical engineer with the General Electric Research Laboratory in Schenectady, N. Y.

**Industrial Instrument Servicing Handbook,** by Grady C. Carroll; 848 pages, 6¼ by 9¼ in. Published by McGraw-Hill Book Co, Inc, 327 W. 41st St, New York 36, N. Y. Price, $16.

Grady C. Carroll joins the list of authors of McGraw-Hill Handbooks with this guide which instrument engineers and technicians should find invaluable. Modern industrial process measuring and control instruments manufactured by 41 companies are detailed.

Twelve sections deal with various instruments and controls. Among these are: Pressure-measuring instruments, velocity- and volumetric-measuring instruments, liquid-level-measuring instruments, temperature-measuring instruments, gas analyzers, and repairing and calibrating controllers.

One additional section is included to furnish information on organizing an instrument maintenance department and selecting its personnel.

An easy-to-follow, step-by-step explanation of each representative instrument reveals principles of operation; methods of servicing, maintenance, and trouble-shooting; and complete calibration instructions.

The handbook is profusely illustrated with organization charts and scheduling systems for preventive maintenance as well as with trouble-shooting charts to assist in locating faulty components without the necessity of completely analyzing pneumatic and electrical circuits. Photographs, circuit diagrams, and other illustrations are also presented.

Mr. Carroll is a leading consultant in instrument maintenance and process control engineering, having formerly been chief instrument engineer of Olin Mathieson Chemical Corp's Energy Division in Niagara Falls, N. Y.

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## MORE ABOUT—
### Vibration

*Continued from page 72*

Figure 7 shows three hand-held vibration-measuring instruments. Item 2 is a mass vibrometer which consists of a dial indicator mounted in a special case to add mass. This instrument is used to obtain a quick inspection. It reads only amplitude of vibration with no relation to frequency. Since it responds to all frequencies, it can show vibration present even when the HQ equipment obtains a zero vibration reading.

If the frequency of vibration is in the range of 500 to 20,000 cpm, the vibration frequency can be obtained by the use of the reed vibrometer shown as item 3, Fig. 7. This instrument consists of a strip of steel which can be extended by rotating two wheels. When maximum vibration is obtained on the reed, the vibrating frequency can be read directly on the handle of the instrument. This instrument is primarily used to measure frequency.

Shown as item 1, Fig. 7, is a Westinghouse vibrograph. This instrument records the vibration on a celluloid strip. The celluloid strip also receives a calibrated timing wave. By use of the microscope shown, amplitude and frequency of vibration can be read, as well as getting a visual picture of the vibration wave.

Vibrographs are often used to obtain the natural frequency of a part. This is obtained by recording the vibration after a rapid blow has been struck to the part. The part will vibrate for a time at its natural frequency. This is known as the bump test. The vibrograph shown can cover a frequency range from from 600 to 15,000 cpm.

For analysis of higher frequencies of vibration, a system may be used such as is shown in Fig. 8. It is suitable for frequencies from 2 to 15,000 cps. Sensing element is an Endevco accelerometer. Essential part of this accelerometer is a crystal which generates a voltage proportional to the acceleration to which it is subjected. Minimum acceleration is 0.15 g and maximum is 30,000 g.

Certain electrical machines may produce either a pulsating torque or be connected to a piece of apparatus that creates a pulsating load. If so, torsional vibrations may occur. Various equipment is available to measure this vibration. THE END

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# PROTECT thermal insulation with

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| *mastics* | 60-25/26 | C. I. MASTICS | Asphalt vapor-barrier weathercoats | M-2-B |
| | *60-30N/60N | FIRE-RESISTIVE MASTICS | Non-asphaltic with nonflammable solvent for boiler walls and breechings | M-2-A, B |
| | 60-80 | SAFETEE MASTIC | UL-listed asphalt "breather" coating for ducts and breechings | M-2-B |
| | 90-07 | H. I. MASTIC | Fibrated asphalt "breather" weathercoating | M-2-B |
| | 60-99 | HILASTIC | Flexible asphalt weathercoat of HiLastic system | M-3-D |
| *adhesives* | *81-42W | LAGFAS | Economical adhesive for lagging canvas on piping | A-2-A |
| *flashings* | 30-46 | INSULATION SEALER | Flexible sealer for flashing insulation | F-2-A |
| | 60-25 | C. I. MASTIC | For sealing laps of vapor-barrier jacketing | F-2-A |
| *coatings* | | *LAGTONE | Flexible fire-resistive coatings in white and colors | C-2-A, B |
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P-2 Bulletin _____

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# CONSTRUCTION NEWS

**Los Angeles, Calif.** — The cities of Los Angeles and Pasadena, Calif, have filed an application with the Atomic Energy Commission for construction of a 50,000-kw nuclear power plant in San Francesquito Canyon, north of here. The Los Angeles Department of Water & Power stated that the AEC would construct and own the plant, to cost an estimated $10,000,000, and that Los Angeles and Pasadena, each, would contribute $5,000,000 for the power-generating facilities. No tentative starting date for the plant has been set as yet, but the proposed plant would be valuable in preparation for future full-scale nuclear power plants with generating units as large as 300,000 kw.

**Los Angeles, Calif.** — Southern California Edison Co, 601 W. Fifth St, has announced plans to begin negotiations on contracts to construct an atomic electric power plant reported to cost more than $70,000,000. Utility announced that it has sent letters of intent to Westinghouse Electric Corp, Pittsburgh, Penna, and Bechtel Corp, San Francisco, Calif, for the design and erection of a 360,000-kw generating station at a site yet to be selected. Westinghouse would design and build the pressurized-water reactor and the steam and electrical equipment for the plant. Bechtel would be the engineer-constructor. Once a starting date for construction of the plant is announced, it is estimated that it will take four years to complete.

**Chicago, Ill.** — Commonwealth Edison Co, 72 W. Adams St, has announced that the 180,000-kw Dresden nuclear power plant, designed and built by the General Electric Company, Schenectady, N. Y., for Commonwealth Edison and the Nuclear Power Group, Inc, is now operating at 88,000 electrical kilowatts, more power than any other nuclear plant in the United States. Single-cycle and dual-cycle system check-outs will be followed by a test period and shutdown for core power-distribution measurement. Upon authorization from the AEC for full power operation, power output of the huge plant will be raised gradually. Plant was completed at a cost exceeding the $45,000,000 originally projected for the installation.

**Marion, Ill.** — Southern Illinois Power Coöperative, Dongola, Ill, has plans under consideration for major expansion and improvement of its plant, located here, with installation of a 99,000-kw steam electric generating unit and auxiliary equipment on the south fork of the Saline River, south of this place. Work on the installation will begin when preliminary engineering work is completed. Plant is scheduled for completion early in 1962 at a cost estimated at $21,000,000.

**Paradise, Ky.** — Tennessee Valley Authority, New Sprankles Bldg, Knoxville, Tenn, is considering plans for the construction of a large power plant to house the largest steam-turbine generator in the world. New plant will be erected on the west bank of the Green River, on a large site, near this city, in the northwestern part of TVA's power service area, adjacent to the vast coal fields in the immediate area. Plans include the installation of a steam-electric generating unit with an initial capacity of 600,000 kw in the plant which will cost a reported $100,000,000. Plant is scheduled for completion early in 1963.

**Detroit, Mich.** — Detroit Edison Co, 2000 Second Ave, has announced that total construction expenditures for 1960 would approximate $70,000,000, as compared with a total expenditure of about $59,000,000 in 1959. Utility plans to invest approximately $50,000,000 annually over the next five-year period on new generating facilities, transmission lines, substations, and other equipment to meet the ever-increasing demand. With a lower level of construction, company is entering a period in which construction funds can be obtained largely from internal sources.

**Minneapolis, Minn.** — Northern States Power Co, 15 S. Fifth St, this city, and Minnesota Power & Light Co, 30 W. Superior St, Duluth, Minn, announced plans to construct a large transmission line joining the two utility systems. Construction of the 142-mile line will begin early in 1962 and will link St. Paul and Duluth, Minn. Work is scheduled to end by the summer of 1963. Project when completed will represent an investment of $8,300,000.

**Sherburn, Minn.** — Interstate Power Co, 1000 Main St, Dubuque, Iowa, has authorized plans for the expansion of its Fox Lake Power Plant located here. The addition, which will include the installation of a steam-electric generating unit with an initial capacity of 84,000 kw and a new boiler, will increase the company's total generating capability about 30 per cent. The company at present has a capability of 273,505 kw. New unit will be the largest in the company's system and will increase the capability of the Fox Lake plant to 109,000 kw. Construction will begin at once with completion scheduled for July, 1962, at a cost of about $12,000,000.

**Asbury Park, N. J.** — Jersey Central Power & Light Co, 501 Grand Ave, is considering plans to construct a new power plant to handle expanding population in Central and South Jersey. The plant, reported to cost about $200,000,000, will be built on Barnegat Bay, in Ocean County. It will be part of the company's long range plans; it will require 15 years to complete the entire project. Preliminary work on the plant is expected to begin early in 1961. Former plans for a new power plant on Gull Island, Point Pleasant, N. J., have been dropped, and property acquired will be offered for sale.

**New York, N. Y.** — Consolidated Edison Co of New York, 4 Irving Place, has authorized plans and work will begin at once on construction of an overhead electric transmission line. The 345,000-v line will carry power from Dunwoodie Substation, Yonkers, to Pleasant Valley Substation, at Poughkeepsie, N. Y.

**New York, N. Y.** — Power Authority of State of New York, Coliseum Tower, 10 Columbus Circle, has announced contract award to the Emerson Garden Electric Co, 2904 Lockport Rd, Niagara Falls, N. Y., in the amount of $2,678,337 for the construction of a transmission line from the Niagara Switchyard, Niagara Power Project, to Rochester, N. Y. Work will begin soon for scheduled completion in about 18 months.

**Poughkeepsie, N. Y.** — Central Hudson Gas & Electric Co, South Road, this city, has announced plans to acquire a large building site of 768 acres on the Hudson River, between Barrytown and Tivoli, N. Y., 25 miles north of here, as a potential site for an electric generating station. Purchase will include Cruger's Island, which comprises about 56 acres. The utility indicated that it would pay about $750,000 for the land if court approval for the proposed project was obtained and if test borings proved the site suitable for the plant. Proposed plant would ultimately have a capacity of 2,000,000 kw.

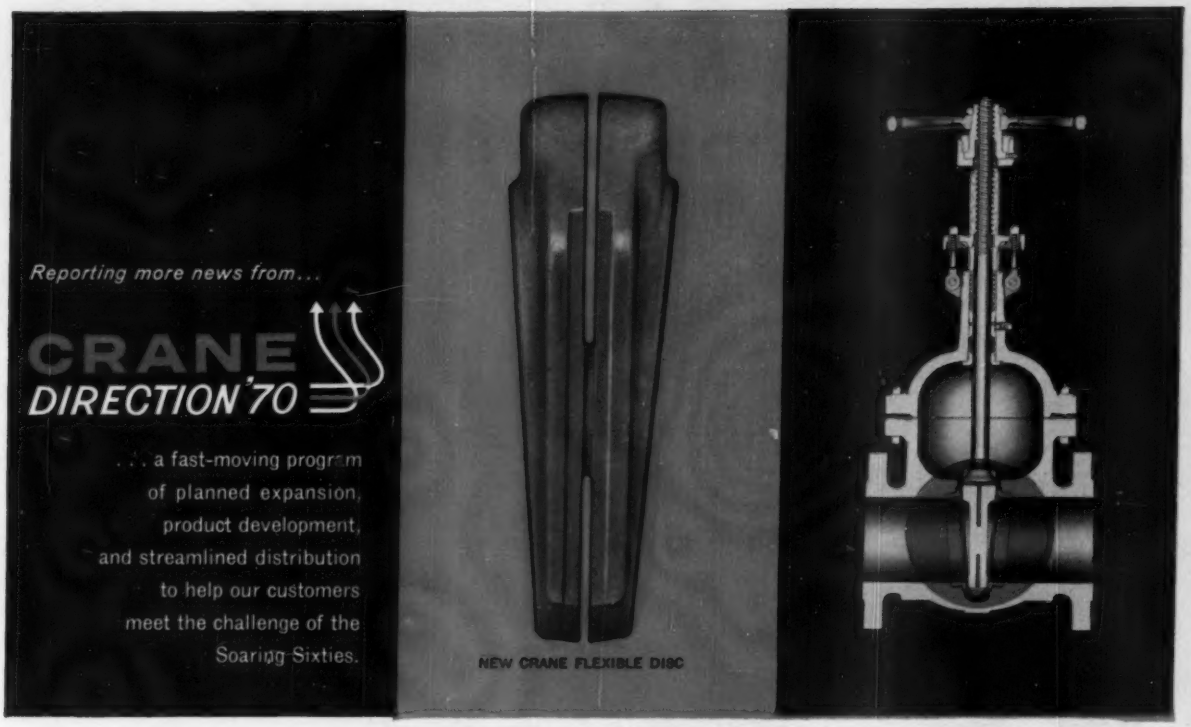
**Goldsboro, N. C.** — Carolina Power & Light Co, 419 Fayettsville St, Raleigh, N. C., has authorized plans for a major addition to its Quaker Neck steam-electric generating plant located here. Plans include installation of a new steam electric generating unit for increased capacity, with an initial capacity of 320,000 kw. Work on the new installation will begin soon at a reported cost over $10,000,000. Plant is scheduled for completion by the spring of 1962.

**Toledo, O.** — Toledo Edison Co, Edison Bldg, has begun plans for major expansion and additions to its Bay Shore Power Station, in East Toledo, O. Plans call for the installation of a third generating unit, including turbo-generator, high-pressure boiler, condenser, and related equipment at a cost approximating $28,000,000. Plans also include additional substation facilities and transmission equipment. Work will begin when preliminary engineering is completed, and plant is scheduled for completion early in 1963. Gibbs & Hill, Inc, New York, N. Y., is the consulting engineer.

**Portland, Ore.** — The Oregon Hydroelectric Commission has granted a license to Pacific Northwest Power Co for construction of High Mountain Sheep Dam on the Snake River between Oregon and Idaho. It was the final state approval required for construction of the 670-ft dam which will cost a reported $255,000,000. Plans for building the 1,520,000 kw project now hinge on Federal Power Commission approval. Pacific Northwest Power Co comprises a combine of Portland General Electric Co, Pacific Power & Light Co, Washington Water Power Co, and Montana Power Co.

**Waco, Texas** — Brazos Electric Power Coöperative, 902 Amicable Bldg, has authorized plans for the construction of a 15-mile, 69-kv transmission line and a new substation in the Waco area.

**Washington, D. C.** — The Atomic Energy Commission, 1901 Constitution Ave, N.W., has authorized a construction permit for the construction of a $27,000,000 nuclear reactor on Lake Michigan in Charlevoix County, Michigan. Permission has been granted to the Consumers Power Co, of Jackson, Michigan, to construct the reactor, which will have an initial capacity of 75,000 kw.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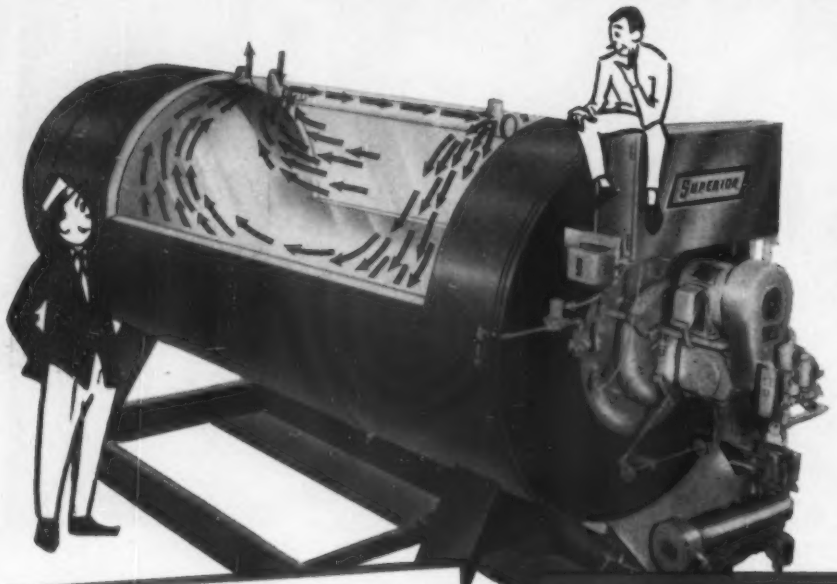


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## Current Catalogs

*continued from page 53*

**146** **Mechanical Vibrating Conveyors** — Catalog 954 of The Jeffrey Mfg. Co. discusses operation and features of mechanical vibrating conveyors. Four types to meet a wide range of applications are presented in this 64-pp book. These include a heavy duty conveyor; a medium-duty, medium-weight conveyor; a low-capacity, low-height unit; and dynamically balanced type for use on upper floors, tops of silos etc. A final section is devoted to feeders, dryers, coolers, screens, other equipment.

**147** **Mechanical Drive Turbines** — Information and data on General Electric Co.'s mechanical drive turbines, single stage types, for pumps, compressors, fans, blowers and similar equipment are contained in 16-pp Bulletin GEA-4955C. Describes such features as balanced-taper valve and includes schematic diagrams and technical data.

**148** **Rubber Hose** — Illustrated and described in Mercer Rubber Co.'s 24-pp Form 1059, is a line of rubber hose for a variety of industrial, processing, and utility applications. Application and construction details are included, along with dimensional data, weight, working pressures in chart form, and information on fittings and couplings.

**149** **Markers, Signs** — Illustrated in full color, this 24-pp catalog of North Shore Nameplate Div., Anodyne, Inc., provides information on pipe and electrical markers, numerals, letters, safety and identification signs, all available from stock. Explains how markers are applied, includes prices and ordering information.

**150** **Molded Packings** — Illustrated and described in 8-pp Bulletin MP-160 are Greene, Tweed & Co.'s molded packings for use on rods and pistons of hydraulic and pneumatic equipment, hydraulic presses, pumps, compressors, steam hammers, and similar machines. Detailed applications data on specific molded packings is presented, as well as data on composition, temperature ranges, application dimensions.

**151** **Centrifugal Fans**—Catalog 1120-1 of Westinghouse Electric Corp. contains 76 pp of detailed information on all-purpose centrifugal fans with flat, backwardly inclined blading. They are suited for supply and exhaust, general building ventilation, industrial air conditioning, industrial processes. Key components and features are illustrated, and tabular performance data and dimensions for application and selection included.

**152** **Sludge Collectors** — Described in 8-pp Bulletin 6751, Yeomans Brothers Co., are normal duty and heavy duty sludge collectors for sewage and waste treatment. Sectional drawings show typical layouts for primary and final settling tanks, and detailed specifications are included.

**153** **Wall Deslagger** — Bulletin 1066 of Copes-Vulcan Div., Blaw-Knox. Co. illustrates and describes the RW-3A wall deslagger with dual air drive for cleaning boiler, superheater and reheating

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**POWER ENGINEERING**
JULY, 1960

**Please have manufacturers send me, without cost or obligation information or literature indicated by the numbers circled below.**

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Company Name.....
(Must be included)

Company Address.....City.....State.....

(If you prefer delivery at home, give home address, too)

Home Address.....City.....State.....

| Equipment | | | | | | | |
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| Current Catalogs | | | | | | | |
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| 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 |
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| Advertised Products and Services | | | | | | | | | | | | | | | | |
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section walls. An explanation of how blowing air or steam is saved by extending and retracting the nozzle almost instantly, and how cleaning is thorough because of slow nozzle rotation is also included.

**154 Perforated Metal Screens** — Applications and specifications for Conidure pierced metal and Rima slit screens used for coal, food, chemicals, water filtration and sewage disposal are detailed in 12-pp Bulletin C101 of Cross Perforated Metals, National Standard Co. Shows typical screen assemblies, perforation and slit configurations, application principles, open area equivalents, and chemical analyses.

**155 Productive Purchasing** — Application of analysis techniques to purchasing methods is detailed by General Electric Co. in 22-pp Bulletin GED-3877. Discusses value analysis — the systematic evaluation of functional value — and includes a checklist for evaluating equipment suppliers which can be used for appraisal of such added values as reliability, technical capabilities, after-sale service, availability, buying convenience, and sales assistance.

**156 Filtration Products—Filter** media for process fluids, nuclear applications, internal combustion engines, hydraulic fluids, machine tool coolants, bulk fuel and other applications are described in 18-pp Bulletin IND-1-60 of Purolator Products, Inc. Explains flow rate, degree of filtration, viscosity of fluids, and gives operating specifications for range of filtration, temperature limits, flow characteristics.

**157 Guide to Silicones** — This 12-pp engineering guide of Dow Corning Corp. explains how various physical forms of silicones contribute to reliability, miniaturisation, modularisation and environmental protection, increase serviceability over wide extremes of temperature. Contains engineering data and processing information on silicones, details electrical and mechanical properties, describes typical applications.

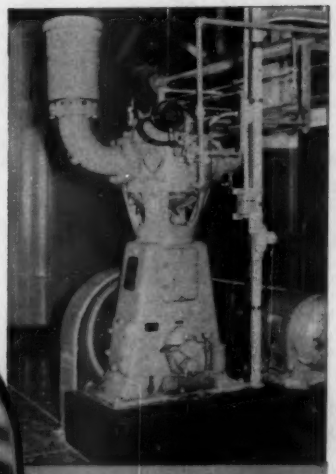
**158 How to Bend Conduit** — This 12-pp pocket-size booklet of Appleton Electric Co. gives instructions for making precision bends in electrical metallic tubing, rigid steel, and rigid aluminum conduit. Covers five fundamental bends — angle bends, stub lengths, back-to-back bends, offsets and three-bend saddles. Diagrams show techniques for on-the-spot bending of small conduits. Includes offset formulas, shrink tables and "gain" tables. Information given is prescribed for both standard type and Powr-Jack type bender.

**159 Scale Model Components** — Vessels, heat exchangers and pumps of molded expandable polystyrene — model equipment which can be worked with knife or hand saw and can be sanded, glued, pinned or screwed — are featured in this 8-pp bulletin of Industrial Models, Inc. Piping system and structural components are listed.

**160 Product Guide** — Product Guide B-5529, 24 pp of American-Standard, gives ratings for air conditioning and air handling equipment, fluid drives, heat exchangers, surface condensers, steel boilers and related industrial products.

*Joy Design Means:*

# CHROME-PLATED CYLINDER WALLS FOR CORROSION RESISTANCE



Joy WGO-9 Compressors supply instrument air in southwestern power station.

Chrome-plated cylinder walls give Joy Oil-Free Compressors longer service life and lower maintenance costs. The intermittant duty typical of oil-free compressor service makes rusting of the cylinders a prime source of trouble. Because of the exclusive replaceable cylinder liner construction, Joy is able to put a chrome face on the cylinder wall which will resist corrosion and also give extra wear. This feature and the exclusive T-Block carbon-graphite compression ring construction make Joy Oil-Free Compressors economical to operate.

Joy can supply positive displacement machines with capacities up to 7392 CFM and dynamic machines in any size desired. For complete details on how to get truly low cost, oil-free air, consult your Joy representative, or write for Bulletin 926-56C.

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**Joy Manufacturing Company**
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# Equipment News

Described on these pages are new and improved products. Use Reader Service Cards on pages 81–82 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

### 1—Automatic voltage regulator for distribution transformers

UNOREG, a self-contained automatic voltage regulator for use on the low-voltage side of over 400 standard distribution transformers, is offered utilities by Westinghouse Electric Corp. Rated at 1¼ kva, the device is designed to handle transformer sizes through 25 kva. (A 2½-kva model will soon be available for transformers through 50 kva.) A compact and lightweight design for pole mounting, UNOREG provides ± 5 per cent regulation of 120/240-v secondary lines. It offers flexibility of application and economy of equipment — you can apply UNOREG to a distribution transformer for $150 plus installation costs, company states.

Development of this regulator is based on studies of hypothetical systems which led to two conclusions: 1. The most economical system is the one built to operate without re-regulation. 2. When necessary, however, re-regulation is obtained most economically by raising voltage on the whole system and then bucking down the voltage at the head of the feeder, as required, with regulators on individual transformers. UNOREG consists of an induction regulator controlled by a solid-state voltage-regulating control. Illustrated is a montage of the complete assembly plus the two basic parts — regulator and control box.

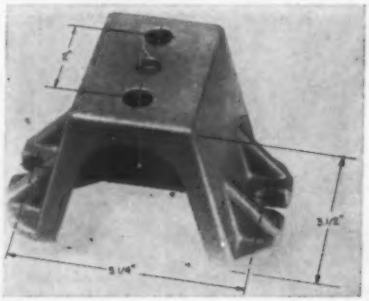
### 2—High voltage equipment is re-designed from ground up

In the 4160-v equipment recently announced by I-T-E Circuit Breaker Co. are circuit breakers and switchgear redesigned to provide improved fault protection, increased safety for personnel and equipment, higher reliability, and simpler installation and maintenance. The breakers are reportedly the first to combine stored-energy closing and ironless blowout in this voltage rating. The stored energy closure utilizes a motor-charged, spring-powered mechanism to provide faster closing of contacts, improve contact life and afford greater safety for personnel. Ironless blowout provides a reduction in arc chute weight for easier handling and faster fault interruptions through improved arc extinction afforded by better magnetic field distribution. Also featured are light weight, compact size and low center of gravity, permitting smaller overall size of switchgear and easier and safer handling — even by one person.

Switchgear construction incorporates reduced size, rugged construction, and improved bus and wiring design. A major advantage is closed-door drawout, with movement from operating to test and disconnect positions accomplished while door remains closed. Besides increasing personnel safety, this keeps aisles free of open doors. Closed door indication is a feature — opening a small sliding panel reveals indicator showing breaker position. Easy access to current transformers is provided. Transformers can be removed from front of switchboard without disturbing bus.

### 3—Heavy-duty insulator for rugged applications

This high-strength A-frame type insulator applicable for high current bus or rail support in heavy-duty industrial use and apparatus requiring a rugged insulator is announced by The Glastic Corp. Features of this fiber glass reinforced polyester insulator include an 8¾-sq. in. top mounting area and a wide base (5¼ in. between bolt centers) offering high cantilever strength and designed for fastening with ½-in. bolts and nuts. The insulator is 3½ in. high (NEMA Class A-20 height), chip and flashover resistant.

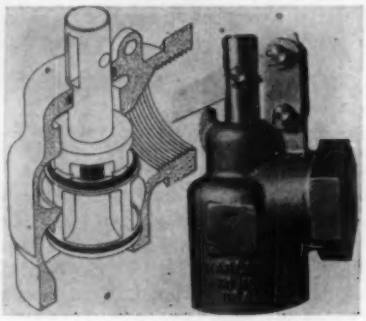


### 4—Stream trap unit includes valves and strainer

Worthwhile savings are claimed by Velan Steam Specialties, Inc., through use of the Type TSV Piping King where only two connections are required to make a complete steam drainage installation. The assembly consists of a forged steel steam trap with integral strainer, check valve and air vent, welded to either one or two forged steel gate valves. Both trap and valves are serviceable in the line, company states, and in less time than it would take to remove a standard valve or trap. A one-piece cage unit contains all steam trap internal parts, and the removal of two screws permits replacement of every part except the body without touching a line connection. Shut-off valves are bonnetless design with screwed-in seats of stainless steel. According to manufacturer, labor savings to 90 per cent and material savings of 60 per cent can be realized on original installations. Type TSV Piping King comes in ⅜- to 1-in. connection sizes for pressures to 250 psi.

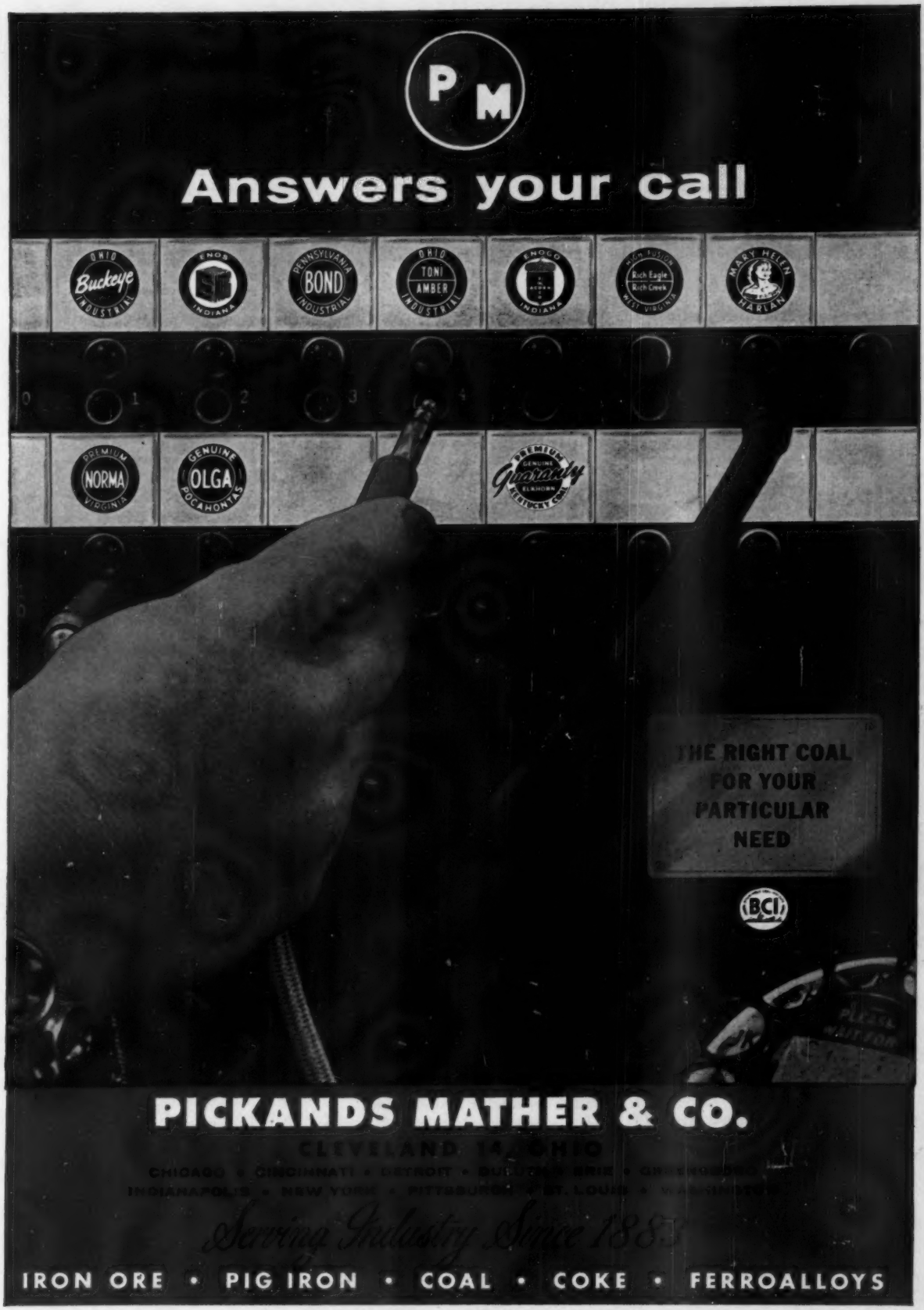
### 5—Simplified float valve has only two main parts

As announced by The Marley Co., this is a non-stick direct action float valve offering mechanical simplicity, operational dependability and maintenance ease — and a pair of pliers does any maintenance job. It has just two basic parts — body and plug. Plug and stem are cast as an integral unit. The body, also cast as a unit, has a threaded inlet opening, and the outlet opening can be threaded if desired. O-rings form stem seal and plug seats. Non-corrosive metals are used throughout.



### 6—Submersible pump handles large volume of water

For installations requiring a large volume of water from 6-in. or larger deep wells, Series UF Turbine Bowl Submersible Pump, of Goulds Pumps, Inc., comes in 16 sizes from 5- to 40-hp units providing capacities to 180 gpm from well

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depths to 1450 ft. Bowl assemblies, varying in number from two to 23, depending on well depth, feature heavy cast iron bowls with baked-on alkyd melamine finish, bronze impellers and stainless steel fastenings. Stainless steel shaft, coupling and non-corrosive intake screen are designed to eliminate rust and corrosion. Motors are water lubricated, prefilled, requiring no external lubrication, and motor leads are protected by a stainless steel guard. Bulletin 650A1 gives further details.

### 7—Corrosion inhibitors improve control of deposits

Two polyphosphate-chromate corrosion inhibitors introduced by Dearborn Chemical Co. feature an organic additive — Endeor A — to provide improved control of corrosion and deposits. Polychrome 501 is intended primarily for use in open recirculating systems employing heat exchangers that appreciably raise the temperature of the cooling water. Polychrome 505 is for open recirculating systems when relatively low temperatures are encountered. According to manufacturer, the organic additive bolsters protective films and has surface active properties which interfere with carbonate and phosphate deposit formulation; as a result, pH of cooling water can be higher and smaller amounts of acids are required. Both products are described as orange-brown, having a density of about 12 lb per gallon, and indefinitely stable in a closed container.

### 8—Cable lugs and splicers are strong, easily installed

With Red-E Lugs and Splicers, you need only a hammer to make a perfect connection to welding and power cables, according to manufacturer, Bernard Welding Equipment Co. To install, you merely insert the stripped cable, then

hammer down a self-contained impact punch. The connectors have large cable size marking and a handy stripping gauge stamped on the side. They come in a range of sizes from No. 6 through 1/0 through 4/0. Connections made with these lugs and splicers are claimed to have increased pull-out strength, higher electrical conductance and a tighter seal against corrosive air and liquids than connections made by many compression type or bolted type methods.

### 9—Thread compound stands high pressures, temperatures

Improved Fel-Pro C5-A is announced as an anti-seize thread compound for lubricating and sealing bolts, studs, flanges etc., at high pressures and temperatures to 1800 F. Performance advantages claimed include increased lubricating and sealing qualities; lower breaking and running torque; non-settling, non-hardening, homogenized composition. Also, says manufacturer, Felt Products Co., this compound can be used in below freezing weather. C5-A's colloidal copper composition actually copper plates metal surfaces, it is stated, and the material can be used on all metals, their alloys and plastics.

### 10—Static control performs all logic functions

Norpak, a static system introduced by Square D Co., is based on the transistor NOR unit designed for fast performance of all logic functions, including AND, OR, NOT and MEMORY, providing rates up to 25,000 per second. Logic elements are packaged in space saving

modules and encapsulated for resistance to shock and environmental conditions. Components can be purchased separately, in six or 20 packs, and applied as desired without regard to phase sensitivity. Norpak is also available in completely engineered systems. Optional monitor lights give visual indication of proper performance, and a simple dynamic sequence tester checks individual NOR units in operation.

### 11—Cold-applied emulsion coatings feature low permeability

Two coatings claimed highly resistant to permeation by chemicals are introduced by Koppers Co., Inc. Bituplastic 33, a polymer emulsion, is announced as a heavy duty protective coating particularly suited for intermittent splash and high chemical fallout areas. Company experience is reported to indicate that Bituplastic 33's permeability is so low that it is the first coal-tar emulsion type coating suitable for use in intermittent immersion. It can be applied by brush, roller or spray and is intended for use on structural steel, for deck areas and on sheet piling. Resistance to abrasion and high temperature tolerance (reportedly up to 400 F) extend the range of probable use. Bituplastic 44 also has low permeability rating. It is used to adhere cellular glass insulating blocks to storage tanks and underground piping, and as an insulation mortar, and as a top coating for insulation.

### 12—Packaged air conditioners are self-contained, high capacity

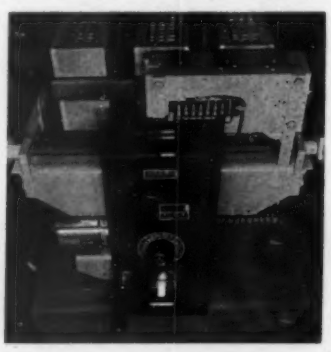
For heavy duty use, these PAC Air Conditioners are announced by Dunham-Bush, Inc., as ruggedly constructed, attractively finished, and for installation either within conditioned area or at a remote location. Panel-type casings are Fiberglas insulated and finished in hammertone blue-gray enamel with vinyl paint undercoating. Available in five sizes from 10 to 30 hp, the units are compact, quiet in operation and easily adapted (in the field) for connection to duct work, manufacturer points out. Larger units have dual compressors. The 10- and 15-hp models are available with free air discharge plenum and may be had with steam coils in the plenum. All can be used with steam coils in the duct system and can be furnished with fresh air inlets. Bulletin 6022 gives details on the units.

### 13—Rubber, in paste form, is all-around repair material

According to manufacturer, Devcon Corp., this material has tremendous strength and is an excellent adhesive for rubber, iron, steel, aluminum, bronze, ceramic, wood, and many plastics. It is described as tough, flexible, easy to use, waterproof and fast setting, as well as unaffected by oil, gasoline and most chemicals. Among suggested applications are sealing or caulking around machinery, insulating electrical equipment, making gaskets, repairing torn conveyor belting, fixing cracks in masonry walls, coating leather belting to reduce slippage, skidproofing wet floors, and use as a coating to protect machinery and piping against rust or corrosive liquids.

### 14—Static trip device works without moving parts

Announced by Allis-Chalmers Mfg. Co., for Type LA low-voltage circuit breakers, is a static overcurrent device with no moving parts. Self-contained, the device is said to require no external source for tripping. Timing and tripping are performed by static trip units energized



from tripping transformers mounted on circuit breaker. Tripping device has an 80 to 200 per cent variable pickup and an instantaneous pickup which is adjustable from four to 30 times the minimum pickup setting of breaker, company says, to provide instantaneous response at lower or higher values of short circuit current. Adjusting pickup current over a considerable range is readily accomplished.

### 15—Bellows flowmeter for flow and liquid level service

This differential pressure measuring device for flow and liquid level applications, a metallic bellows flowmeter, is announced by Fischer & Porter Co., as accurate to within ½ of 1 percent, using no mercury, seal-pots, purges, or stuffing boxes. The meter body is self-draining,

self-venting and rated at 2000 and 5000 psig in steel and stainless steel. The flowmeter has ranges from 0-20 to 0-300 in. of water and may be changed by an exchange of the range spring assemblies. The indicating and/or recording instrument can be equipped with a controller, totalizer, or transmitter.

### 16—Analyzer monitors trace solids in feedwater, condensate

This automatic tape analyzer, developed by Graver Water Conditioning Co., is designed to detect trace solids in feedwater and condensate. Current Model 302 monitors insoluble solids but can be modified for solubles, company says, and possibly for radioactive particles. It is based on the Millipore filter test method in which particulate material is quantitatively removed from a liquid or gaseous sample by an ultrafine filter membrane and retained on the filter surface for identification.

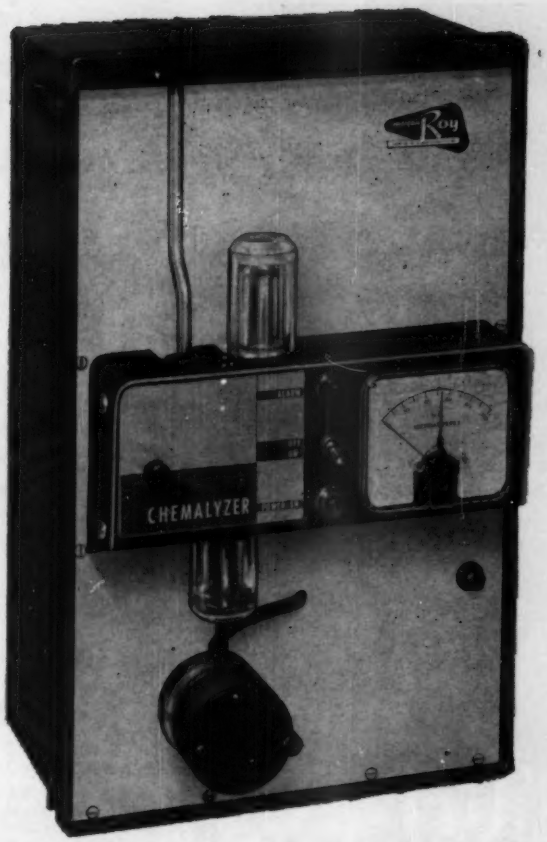
The tape analyzer automates this test by filtering sample in sequence through

a nylon-backed tape of filter membrane, and printing the time each sample is taken. Basic data produced is a circular discoloration on the tape made by solids extracted from the filtered fluid. Degree of discoloration, proportionate to insoluble solids concentration, can be calibrated by analyzing a portion of a sample and then running another portion through the tape analyzer. A strip chart recording attachment is also available.

The analyzer has varied power plant application. On startup and restarts it can serve as a basis for estimating amount of rinse required, can signal when system is clean and record cleaning effectiveness. During operation it can keep operators informed of level of insoluble solids in the cycle and forewarn of possible trouble. In trouble shooting, it can pinpoint the location of solids pickup. As a control instrument, it can measure effectiveness of the filters and signal need for cleaning. It can measure effectiveness of components in the power system. In condensate scavenging, it can measure condensate purity.

### 17—Flexible steel conduit protects wiring in wet areas

Sealed Skin, flexible steel conduit featuring a polyvinyl chloride synthetic resin cover and UL approval as protection for wiring used in wet areas, is announced by The International Metal Hose Co. for use on pumps, welders, grinders, blowers, conveyors, tools etc. In addition to keeping wiring dry, Sealed Skin has a copper wire positive ground, company states, and it absorbs vibration and resists flame, oil, grease, dirt,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chemicals, fumes and salt spray. It is said to install easily, even where U bends are required, and space is limited, and its flexibility suggests use as conduit for connections between moving members and stationary parts. The ⅜-, ½- and ¾-in. sizes have square locked construction and heavy galvanized steel core. Sizes 1 and 1¼ in. have interlocked galvanized steel core.

### 18—Heavy duty sump pump has big pumping capacity

Model 330 is a heavy-duty, ½-hp, three-phase, 60-cycle industrial sump pump announced by Kenco Pump Div. for 230-v operation with 3-amp maximum operating current. Completely submersible, Model 330 features bronze

construction, direct-drive non-clog, bronze impeller and sealed oil-filled motor chamber. Automatic and non-automatic types are available. The former has a pumping capacity of 5000 gph at a 10-ft discharge head; it includes pump, external liquid level control and motor starter and is said to need no adjustment. The non-automatic model is furnished as a pump only without starter and overload heaters. Both types have 10- or 20-ft waterproof, oil-resistant power cord. According to manufacturer, Model 330 is lifetime lubricated, compact, easy to install and ruggedly built for sump operation in utility tunnels, elevator pits, transformer vaults.

### 19—Brinemaking device makes gravel bed unnecessary

The all-plastic Fluitron is a Morton Salt Co. brinemaking device said to create exceedingly high brine make-up rates and eliminate need for gravel supporting beds when dissolving high-purity fine-grained salts. It diffuses water through the salt bed and also collects brine for discharge to the brine-use system. It is pointed out that by eliminating the gravel bed and extending the salt capacity of dissolving vessel, Fluitron makes frequent charging unnecessary.

### 20—Sweep balance Btu meter for industrial, commercial use

For accurate assessment of heating or cooling costs on the basis of recorded consumption, this sweep balance Btu meter is a development of Air Conditioning Equipment Corp. It is offered for chemical processing and other industrial operations, as well as for use in commercial buildings. Described as simpler in design than other Btu meters, it requires no amplifiers. It employs electrical resistance thermometers and an


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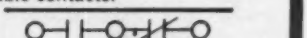
AUXILIARY CONTACTS N.O.-N.C. standard with most plug-ins.

SEQUENCE OPTION after installation by means of independent slide switch at each point.

DE-LINE plug-ins are self-policing. Systems are rugged and dependable.

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electromechanical computing device. Turbine-type flowmeters are designed to make possible high counting accuracy over the full range of flow rate.

Due to exceptional temperature sensitivity, this meter can be used for cooling systems where the temperature difference is only a few degrees F, company notes, and with it you can even use just one instrument for both heating and cooling with a single system. In this case, heating and cooling measurement would be indicated on separate dials. Available accessories include a remote counter or a strip chart recorder that can be placed any distance from the integrator. The recorder gives Btu's consumed at any hour during the day or night.

### 21—Steel gate valves incorporate flexible wedge disc

Flex Gate Valves are 150- and 300-lb steel flexible wedge disc gate valves. Working pressure of the 150-lb model ranges from 40 psi at 1000 F to 275 psi at 100 F; the 300-lb valve has a range from 85 to 720 psi at similar temperature range. Announced by Crane Co., as costing no more than conventional solid wedge disc gate valves, these offer advantages for rugged service in refineries, power, chemical and other industries. Flex Gates operate easily, even if closed while hot, and then permitted to cool, manufacturer states. As the body seats pinch the disc, it flexes slightly to conform to the new seating position. New Flex Gates do not stick closed, it is noted; they seat and unseat with minimum torque, and the no-sticking feature means minimum scrape and wear of disc and seats. The flexible wedge disc also serves to compensate for minor misalignment of seats due to pipeline deflection. Body and bonnet are cast carbon steel with heavy metal sections. These valves are designed for economical servicing. Body seat rings can be replaced and seating faces refinished.

### 22—Circuit breaker uses 40 per cent less panel space

This molded case circuit breaker for short circuit protection of motor circuits is available in continuous current ratings up to 100 amp with an interrupting rating of 15,000 amp at 600 v a-c. An expansion of I-T-E Circuit Breaker Co's. line of ETI breakers,

it provides in the small EH frame the same protection previously available only in larger F-frame breaker. Breakers feature selective short circuit protection for electric motors through an adjustable magnetic trip which can be set just above start-up inrush current to prevent unnecessary tripping. This adjustment provides five settings for instantaneous

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MEG® TYPE OF MEGGER INSULATION RESISTANCE TESTER—Available hand-operated, rectifier operated, or with a separate rectifier. Ranges up to 2000 megohms and 1000 volts d-c in all three models. BULLETIN 21-45-PE

MEGGER GROUND TESTER measures the resistance of earth to ground connections simply, easily and accurately, and thereby helps to determine whether such connections will perform the services for which they were designed and installed. BULLETIN 25-PE

MEGGER LOW RESISTANCE OHMMETER—Battery or rectifier operated. Four ranges 0-1000 microhms to 0 to 1 ohm. New clamp type test leads 18 ft. long enable one man to make tests. BULLETIN 24-46-PE.

B1014

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**Electrical & Speed Measuring Instruments**

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# THE LONERGAN LINE

**HOW TO SAVE WEAR AND TEAR ON MEN AND VALVES**

by A. J. Schmidt, Chief Engineer

Power plant users of relief valves in liquid service are undoubtedly all too familiar with chattering. Valves hammer away, annoying plant personnel and running up maintenance bills.

Even with this undesirable operation, these

valves have been acceptable for application where the valves are seldom, if ever, called upon to relieve. For use under critical applications, such as pump by-pass, where the valve is normally open, or where opening is a common occurrence, it has been necessary to use expensive diaphragm or piston operated valves to eliminate objectionable chattering.

A new series of valves, called Lonergan Hydro-Valves have been under test in dozens of leading plants for the past three years. As a result, Lonergan can provide power plant operators with a valve that is guaranteed not to hammer, chatter or drum on any application, by-pass or emergency relief. At the same time, full-rated liquid flow is maintained. The chatter free operation is provided by a patented, unique design of throat, seat and baffle construction. Use of the Hydro-Valve helps to: save human nerves; prevent loss of plant fuel or product; reduce maintenance on valves and piping; and eliminate interference with delicate control systems. Hydro-Valves are available in all regular body and trim materials in sizes ranging from 1 to 8 inches.

*Full details and descriptions are available in our new Hydro-Valve bulletin. Why not write for your copy today?*

Alvin J. Schmidt

Lonergan

J. E. LONERGAN CO., 207 RACE STREET
PHILADELPHIA 6, PA. SINCE 1872

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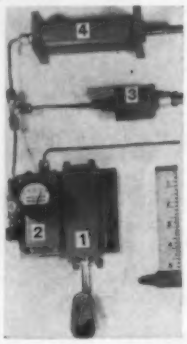
magnetic trip from front of breaker, eliminating need to disconnect cable or open breaker while changing settings.

### 23—Safety control system has its own power source

The Calcon Safety Control System of California Controls Co. is sensitive to a wide range of temperatures, pressures or both in combination and can be assembled into compact units to serve diversified operations. The unit is designed to operate through a small captive charge of compressed air and provide immediate response. When dumped to atmosphere by pressure or temperature sensing devices, it puts into operation almost any type of pilot operated valve, switch, warning or other control. According to manufacturer this is the only self-powered safety control designed to sense pressures to 2000 psi. Set points are adjustable.

Equipment required for a typical small diesel engine installation is shown




in the photo of the Calcon Kit 460. Basic elements are (1) hand charging unit, (2) pressure sensing valve with charge air gauge, (3) temperature sensing valve, (4) actuating unit. Using standard sub-assemblies, a safety control system can be built up to meet the needs of almost every type of equipment. The system is reported particularly suited to unattended machinery.

### 24—Pocket radio requires less battery power, weighs less

Voice Director, introduced by General Electric Co., is described as an all-transistorized shirt-pocket radio communications receiver with miniaturized circuitry that boosts audio efficiency and requires 35 per cent less battery power than previous hand-carried message equipment. It weighs only 12 oz with battery. Although power consumption is reduced, this device is claimed to have receiver selectivity and sensitivity comparable to larger radios.

On standby, the Voice Director uses only 32.5 mw (5 milliamperes at 6½ v) as compared with more than 50 mw in many pocket radio designs. While a message is being received, the power drain is 58.5 mw, reportedly one-sixth that of previous units. For indoor and outdoor voice-paging, the equipment enables the person wearing it to be contacted by a base station transmitter, a a two-way radio in a car, or portable unit operating on the same frequency. Initially frequencies in the 150–174 mc range will be used.

Because less power is used, a smaller battery — a 6½-v single mercury type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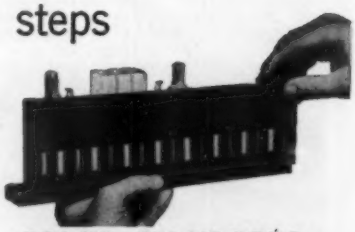
give you fast accurate tests for pH, phosphate, nitrate in just 3 simple steps



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101 pages of technical data and useful information. Gives theory and application of pH control. Describes Taylor line.

W. A. TAYLOR AND CO.
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— is used. Contributing to the Voice Director's reduced power requirement and energy storage is a ferrite loop-stick used for an antenna, built in the receiver's case. A tiny directive horn, which clips to the lapel, is used when privacy is not required. Use of the "directed voice speaker" reduces need for extra amplification in the receiver itself.

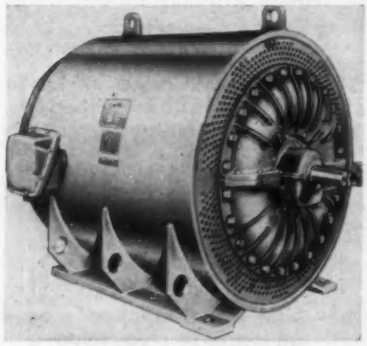
### 25—Steam trap is non-cycling thermostatic unit

While utilizing the sensitivity of the thermostatic principle, the Class TM Trap is described as a balanced double bellows unit which modulates with degree of flow. Several advantages over constantly on-off cycling traps are reported by manufacturer, The C. E. Squires Co., including reduced maintenance, as its modulated operation promotes longer bellows life. Its design also permits use of proportionately greater orifice for higher capacity, manufacturer points out — 0.460 in. on ½-in. size handles 17,500 lb of condensate per hour at 125 psig. Thus, the Class TM Trap is said to have a capacity rating comparable to that of a large bucket trap, yet requiring only a fraction of its installation space and light enough to be supported by the condensate return line on which it is installed.

This trap is also claimed to improve heat recovery of process equipment, removing condensate and air from the trap itself and assuring a dry line ahead of it. One size trap operates from 1 to 150 psig without orifice change.

### 26—Heat exchanger motors work in rough environments

Tube-cooled motors, ranging to 2000 hp, are announced by the Louis Allis Co. in standard enclosed construction for use in non-hazardous locations and in explosion-proof construction with UL



Class 1, Group D label for hazardous locations. These air-to-air heat exchanger motors are designed to operate in unfavorable environmental conditions, providing protection against excessive moisture, oil vapor, chemicals, alkalies, coolant and air-borne dust, sand, dirt and metallic particles. They are suggested for use on pumps, compressors, fans and blowers, crushers, conveyors, etc. Bulletin 2400 gives details.

### 27—Reflective markers for electric service equipment

These pressure-sensitive number, letter and kva markers are said to reflect up to 200 times more light than a white


AIR POWER

means efficiency, speed and economy with AIRETOOL PRODUCTION and MAINTENANCE EQUIPMENT

AIRETROL Tube Expansion Control for fast, precision tube rolling. Rugged air-motor drive speeds operation and an automatic torque sensing control stops expansion within .001 inch of predetermined setting. Lightweight and easy to handle. Permits one man to roll 12 tubes a minute.

MODEL CC-475 heat exchanger and condenser tube cleaner. Weighs just 11 pounds for easy one-man operation without supporting rig. Air-motor driven to deliver all the power needed for cleaning clogged tubes up to 1 inch in diameter. Built-in flushing system keeps drill head cool and tubes clear.

Into every piece of Airetool pneumatic equipment goes more than 30 years' experience in pioneering design and development of powerful, efficient air-motors. The result is a complete line of performance-proven pneumatic tools that help speed fabrication, assembly operation and maintenance with substantial savings in costs. Airetool equipment is engineered for fast, easy handling that permits the operator to work faster over longer periods without tiring. Write today for information on Airetool's full line of pneumatic production and maintenance tools that includes drills, screwdrivers, nutsetters and grinders.

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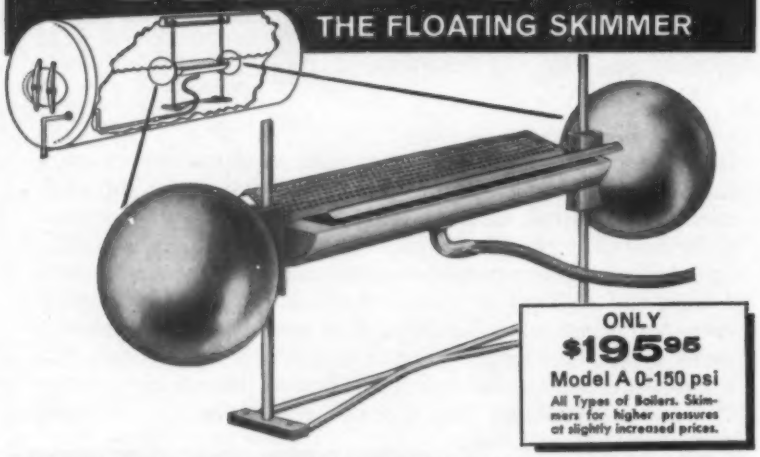

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All Types of Boilers. Skimmers for higher pressures at slightly increased prices.

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SurfBlow automatically skims off boiler water impurities from the critical steam release zone, whatever the turbulence or water level fluctuation. Simple to install. Made of maintenance-free stainless steel. Pays for itself in weeks—even days! Write now for complete information.

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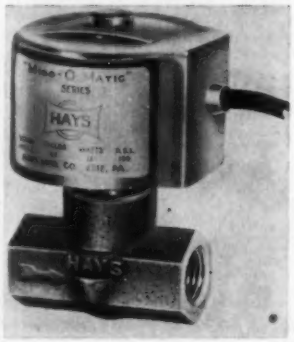
painted surface and be suited for use wherever permanent, day-and-night identification is needed. Applications include transformers, capacitor banks, poles, breakers. Besides being easier and less costly to apply than many identification methods, these markers cost practically nothing to maintain, says manufacturer W. H. Brady Co., and they remain bright and readable for years. An overcoating protects marker surface. Letters and numbers, 2½ in. high, are yellow on a black background. Kva markers are stocked in most NEMA approved ratings 3 through 500. Available as companion products are anodized aluminum panels for use in making rating plates. Bulletin 537 gives details.

### 28—Valve provides automatic control of flows

Developed by Hays Mfg Co, for applications where space is limited, this solenoid valve, the Midg-O-Matic is designed to provide for accurate automatic




control of small flows of water or air. Available in a wide range of voltages and solenoid types, the valve may be secured in angle or straight pattern. It has a range of working pressures to 150 psi, and is available with moisture-proof or waterproof solenoid coils.

### 29—Loop type cable clamp in improved, stronger version

This familiar one-nail-or-screw plastic loop type cable clamp, of Commercial Plastics Co., now has a molded rather than heat formed contour, said to give it not only greater strength at critical angles but a plastic "memory" in the shape-of-use position. It is deformed only to insert the cable, tubing, etc.

### 30—Damping compound sprays on metal to stop noise

Vibrodamper Compound is described as a viscoelastic material which, when sprayed or trowelled onto metal plate, drastically reduces structurally borne noise and vibration — rendering the plate acoustically equivalent to a sheet of cork. It is designed to reduce noise transmitted along structural paths through sheet metal, and the drumming noise created by vibration or thermal movements of metal plates. Manufacturer, The Korfund Co., Inc., suggests it as an effective, economical treatment for sheet metal applications such as air ducts, plenums, curtain walls, computers, transformers, metal floors, pumps, vibratory feeders.

Vibrodamper Compound is claimed more efficient than other damping ma-

terials. Bituminous mastics or single layers of metallic foil provide a vibration decay rate of 3 to 5 db per second, it is pointed out, while this compound provides a rate of 35–55 db. It is also reportedly 100 times as effective for vibration damping as a ½-in. thick, 6-lb density glass fiber blanket. It goes on like paint and dries to a smooth finish. This finish is non-toxic, non-flammable, company says; it resists alkali, grease, gasoline and aliphatic oils, is unaffected by ozone or sunlight.

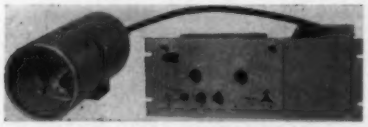
### 31—Adjustable-speed drives offer economical control

Economical, adjustable-speed a-c drives in the Magnaflow line of Westinghouse Electric Corp., are of integral-unit construction rated ¼ to 100 hp, (larger drives with separate motor mounted on a bed-plate are offered up to 700 hp liquid cooled). This electromagnetic drive is designed to apply adjustable speed power to conveyors, fans and pumps, etc. The drive can be set before or during operation to deliver any speed within its range. Speed can be adjusted quickly, and it remains adjusted, company states; a built-in tachometer monitors output speed and automatically corrects it, regardless of load changes.

A feature is the compactness of the control for this type of drive. Standard excitation and regulator control for air-cooled drives up to 30 hp measure only 9¾ by 8¼ by 24¼ in. Because of the small excitation requirements, Magnaflow Drives are adaptable to electronic or magnetic amplifier excitation control.

### 32—TV system designed to stand extremes of environment

Model RGS-10 Ruggedized Television System is said to withstand weather shock, vibration, noise, salt spray and dust, and is intended for areas where a high performance, rugged camera is needed. The system, a product of Dage Television Div., Thompson Ramo Wooldridge Inc., consists of camera and camera control capable of operation up



to 2000 ft apart. The camera weighs only 15 lb, is 16 in. long, requires no additional housing. The control also weighs 15 lb. The system is totally transistorized. It employs modular construction using plug-in transistorized printed circuit modules, each representing a particular function of the camera. The equipment has provision for selection of manual or automatic light level compensation. Another feature is provision of noise reduction circuits to present a clean picture at low light levels. No additional equipment is required for pick-up of visual information. The complete system draws only 15w, 115-v a-c, 50-60 cycle or 400 cycle (optional).

### 33—High lift pump offers operating and maintenance economy

Hi-Lift uses a corkscrew-like rotor which rotates within a contoured stator, creating a positive displacement action


See why

# FOAMSIL®,

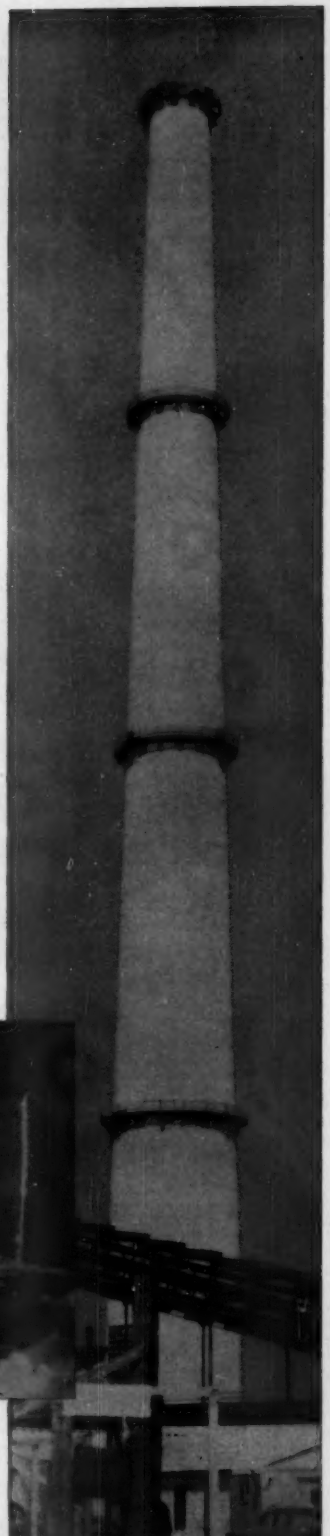
the acid-proof refractory lining, lengthens chimney life

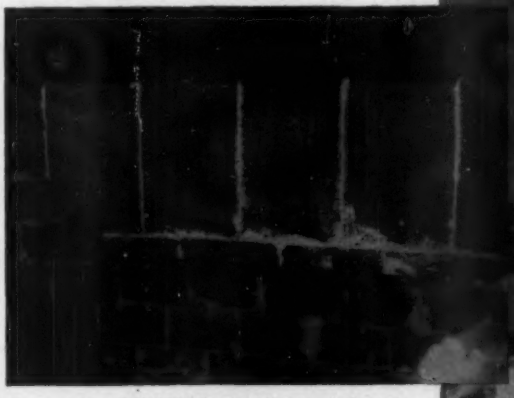
Chimney life is increasing thanks to linings of FOAMSIL, the new insulating refractory by Pittsburgh Corning. This 99% pure foamed silica is completely impervious to acids, is not affected by hot, corrosive industrial gases.

FOAMSIL can take continuous operation at temperatures up to +2200°F . . . and stands up under temperature cycles ranging from −450°F to +1600°F.

Installation is a simple, low cost operation with FOAMSIL. Light in weight, it is easy to handle, yet strong and rigid—can be cut quickly and accurately with ordinary tools. It is available in blocks 17″ x 22″ in a variety of thicknesses, starting at 2 inches.

Put an end to costly relining of chimneys with materials of sometimes questionable serviceability. Write today for a sample, descriptive literature, and examples of successful FOAMSIL applications. Pittsburgh Corning Corporation, Dept. PES-70, One Gateway Center, Pittsburgh 22, Pa.





Pictured is a FOAMSIL lined chimney at Consolidated Edison Co.'s Arthur Kill Station. The inside was first coated with an acid-proof bituminous compound, then 2-inch thick FOAMSIL blocks were applied against it. A half-inch air space was allowed, and the interior completed with a lining of acid-resistant brick. The mammoth 500-ft. chimney serves a 335,000 KW capacity steam generator boiler.

PITTSBURGH pc CORNING

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which squeezes water upward. It is a product of Peerless Pump, Hydrodynamics Div., and, according to manufacturer, can be operated at half normal pump speed (1760 rpm). This contributes to longer pump life, it is noted, and the rotor-stator pumping element suits the pump for sandy wells. Sand particles which may become momentarily depressed in the rubber when the motor passes over it, are removed by the water flow as the rotor continues to turn.

To minimize corrosion problems, the rotor is chrome plated stainless steel, and non-bearing shaft surfaces are enamel finished, and the shaft is equipped with chrome-plated swaged bearing sleeves. The Hi-Lift is said to develop high pressures without change or adjustment, desirable when pumping into pressure tanks or elevated tanks. It is also claimed adaptable to varying pumping conditions — if water level in the well should drop, the pump can be lowered by adding extra sections of column. Four series cover capacities from 500 to 3300 gph, lifts to 1000 ft, pressures to 50 psi. Bulletin B-142 gives features.

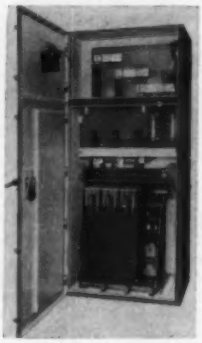
### 34—Control systems for the internal combustion engines

These pneumatically actuated control systems are introduced by Fulton Sylphon Div., Robertshaw-Fulton Controls Co., for automatically starting, loading and shutting down internal combustion engines. The systems incorporate safety functions designed to signal or shut down the engine due to malfunction of any one of an unlimited number of measurable variables. Sequence starting and stopping functions include specific steps as required by the individual engine installation. Start and stop functions are controlled in sequence and interlocked.

The system is described as inherently explosion-proof and the building-block concept provides versatility. The system is dead-ended and there is no consumption of air while engine is running or during shut-down. Measurable variables are monitored continuously — temperatures, pressures, liquid levels, vibration and engine speeds. A feature is the non-resetting characteristic of the annunciators, flush mounted on the control panel. Indication of the specific abnormal condition causing shut-down remains visible until "cleared" — usually automatic with engine restart.

### 35—Air break starter gives fuseless 100/150 mva protection

Type ZHA, a high-voltage air-break starter designed to combine fuseless fault protection with simplified servicing, is available from the EC & M Div., Square D Co. Certified interrupting capacity is given as 100,000 kva at 2400 v and 150,000 kva at 4800 v. Phase barrier and



arc-chutes slide out horizontally for easy maintenance. Both front and rear contact tips are accessible. Since all maintenance can be done from the front, starters can be mounted against walls or back-to-back. A three-way door interlock serves to provide personnel safety; with the door open, blades are visible and in the open and grounded position. Information is in Bulletin 8130-A.

### 36—Ultrasonic unit shows up any "bubbles in the brew"

Taylor Instrument Companies' Ultrasonic Bubble Detector is designed to detect undesirable or controlled bubbling in almost any liquid — flowing or static — in open or closed vessels, pipes, or flumes. It can be coupled with indicating, recording or controlling instrumentation, or simply with an alarm. Experimental use has been with bubble detection in film emulsions, lubricating oils, water, etc. Other uses suggested include automatic inspection for leaks in radiators or any closed vessels which can be submerged in water and filled with air. The detector can be used with hard-to-handle liquids, it is stated, and it detects individual bubbles as readily as quantities. Strength of output signal varies with size and number of bubbles.

Sensing head assembly, at the process,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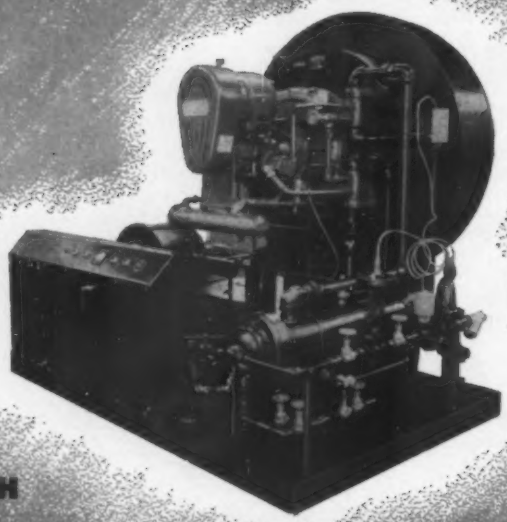

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This complete burning system is engineered for extra economy, lowest maintenance costs . . . one self-contained unit including burner, forced draft fan, air-fuel controls, enclosed electric panel, prewired and mounted on base assembly. Also TODD "SAV-PAC" Register Type Burner System.

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is cable connected in a continuous loop with amplifier unit, which may be remotely located. A pulsed ultrasonic signal passes through the liquid which is likewise flowing between transmitter and receiver heads. Presence of bubbles weakens or interrupts signal. No air supply is required, and a noteworthy safety factor is use of a non-radioactive power source. Technical Sales Letter 6 gives details.

### 37—Electric bulb produces almost 60,000 lumens with 1750 w

This bulb is a Fluomeric, a development combining features of incandescent, fluorescent and mercury vapor lighting, and designed to screw into an ordinary incandescent mogul socket. Previously Fluomerics have been produced only in 450 and 750 w. The new 1750-w size delivers almost 60,000 lumens, states manufacturer, the Duro-Test Corp., and is life-rated for 10,000 to 12,000 user hours. It is available in 208 and 230 v with a BT-56 bulb shape and mogul strap base, in clear (for narrow-beam distribution, as in high-mounted applications) and in Power-Lite (for use where dust is a problem).

### 38—Conveyor belt hauls loads up the steep slopes

Clear Top Belt has diagonal ridges on its top to facilitate carrying wet sand, gravel, dry grain and other materials up steep slopes. A product of Hewitt-Robins Inc., it is designed to rise as high as 21 deg without slip-back. When belt is operating with diagonal ridges pointing in direction of belt travel, moisture in the load is retained uniformly throughout length of belt. If belt is run with open ends of diagonal ridge trailing the direction of travel, water is drained off the material being transported. Belt comes in widths from 12 to 30 in.


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**ANSWER**

**to Worthington Hidden Value Puzzle**

The fictitious "hidden value" on the back cover is, of course, the "Full Floating Wrist Pin" in the piston. This construction is found only on light duty compressors with single acting cylinder construction.

Because all Worthington horizontal compressors are heavy duty machines, they are built with the crankshaft, connecting rod and crosshead linkage system illustrated above. It changes rotary shaft motion to linear piston motion without side thrusts on the cylinder walls. Thus wear is reduced and compressor life increased. Worthington Corporation.



# FLUIDICS* AT WORK

## Skid-mounted "package" demineralizers available promptly from Permutit

Just connect the influent, effluent and waste lines, and this "package" demineralizer will go to work for you. No field assembly costs, no delays, no capital tied up in construction.

It's one of several demineralizing systems now available as pre-assembled packages from Permutit. They're skid mounted, and most models can be shipped promptly from stock.

You save testing expenses, because these package units are pretested, factory-guaranteed units.

Here are some of the "package" units now available:

**12", 15", 20", 24" Mixed-Bed Demineralizers** provide flow rates up to 20 gpm (50 gpm for polishing). All of these units are capable of producing demineralized water with an average of over 6,000,000 ohms specific resistance, or about 0.05 ppm dissolved solid content—*all available from stock.*

**16", 24", 30" Diam. Single Bed Demineralizers** are available as cation exchangers and as anion exchangers—both strong base and weak base. Flow rates up to 30 gpm. All components are carried in stock—permitting prompt delivery of two-bed systems for simple field assembly—or available as a pre-fabricated package, similar to picture above.

**Non-Regenerable Demineralizers** are available for those applications where it is more economical to discard the resin and replace it than to regenerate it. For example, demineralizers used for radioactive waste clean-up, and for polishing ultra-pure or "ultimate" water, may be of this type. Available from stock.

**MBD-6A Mixed-Bed Demineralizer** for laboratory use, demineralizes 1 to 2 gpm of water to a low total solids, low $CO_2$ and low silica content. Unit is 6" in diameter. Available from stock.

More detailed information on Permutit Packaged Demineralizers is given in Bulletin 4721. For your free copy, write our Permutit Division, Dept. PE-70, 50 West 44th Street, New York 36, N. Y. In Canada, The Permutit Company of Canada, Ltd., 207 Queen's Quay West, Toronto 1, Ontario.

*FLUIDICS is the Pfaudler Permutit program that integrates knowledge, equipment and experience in solving problems involving fluids.

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## PATHWAYS OF A PIONEER

ILLCO-WAY DESIGNERS AND BUILDERS

MODERN EQUIPMENT FOR ionXchange

1954 Unprecedented when installed, this huge (5000 gpm) automatic mixed-bed ionXchanger is still the world's largest (in continuous flow rate).

This power plant, where the big ion-Xchanger shown above is installed, furnishes steam for much of mid-town Manhattan.

### Blazing New Paths In De-I Developments

IWT originated the Mixed-Bed De-Ionizer in 1949, and *automatic* versions of this high-performance equipment have been in use since 1953. The big one shown above delivers an unbelievable volume of water of "fantastic purity" (to quote the operators). For example, soluble silica in the feed water for the high-pressure boilers runs .01 ppm or less, and other impurities are unmeasurable. Such performance is in accordance with design specifications and proposal promises. Such successful pioneering has paid off handsomely for later purchasers of IWT equipment.

**THIS EXPERIENCE CAN MEAN A LOT TO YOU**

**If you need pure water for high-pressure boiler make-up or process use, or if you are considering the use of ion-exchange for purification or concentration of chemical products, be sure to take advantage of IWT's 22 years of experience and vast array of specialized knowledge. *Call your IWT representative.***

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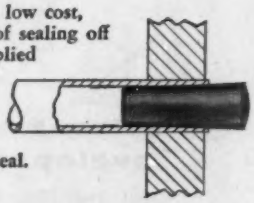
# HERE'S A FAST WAY TO CLEAN CONDENSERS

You can do a fast efficient job of cleaning condensers with Wilson air or water operated Blo-Gun Cleaners. They speedily remove such soft deposits as mud, algae and marine growth by the plug shooting and washing method.

**WILSON BLO-PLUGS**—These corded rubber, scouring type, plugs fit close into the tube and may be used many times over.

**WILSON BLO-BRUSHES**—The spiral Blo-Brush is composed of durable stiff nylon bristles terminating with a plug end. The ends are slightly under the tube size allowing water to simultaneously flush ahead of the brush. They have exceptionally long life and may be used many times over.

**WILSON TUBE PLUGS** offer a low cost, quick and effective method of sealing off leaky tubes. They can be applied instantly in a minimum of time . . . can often be used over again. Only a minimum amount of driving is needed to assure a positive seal.



**TUBE WALL REDUCING TOOL.** This tool is used as a preliminary operation for the removal of tubes. The wall of the tube is reduced to a very thin section at the rolled joint thus relieving pressure and facilitating removal. OD of tool slightly under tube OD. Cutting type pilot will enter dirty tubes. Will not drift and damage tube sheet.

**WILSON MODELS 41 AND 44 TUBE EXPANDERS** are modern tube expanders for the *precision rolling* of condenser tubes. These expanders incorporate an improved, adjustable ball bearing thrust collar and are designed for efficient, easy rolling and maximum roll length adjustment for various tube sheet thicknesses.

*Write for comprehensive Catalog 77-88.*

**Representatives in principal cities**

**THOMAS C. WILSON, INC.**

**21-11 44th Ave., Long Island City 1, N.Y.**

**Cable Address: "Tubeclean," New York**

TW800

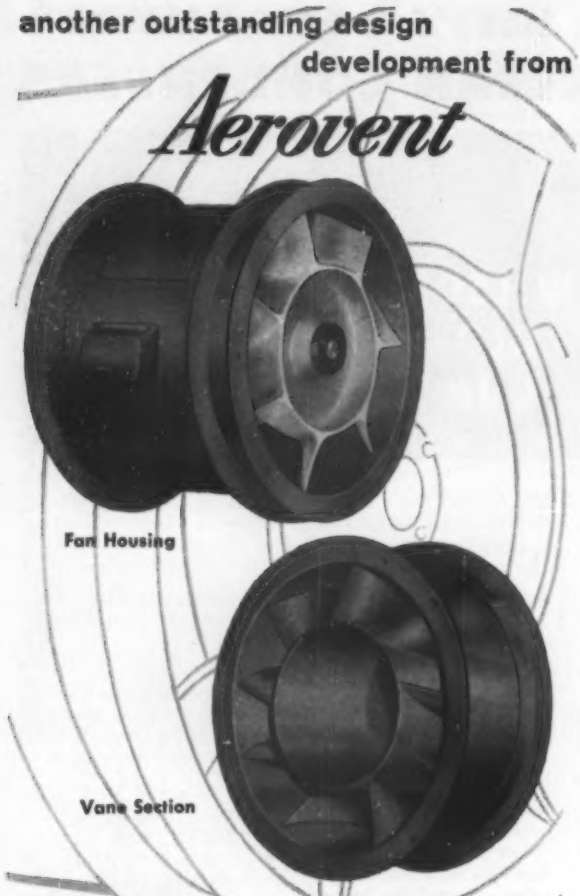
**WILSON**

**BETTER TOOLS FOR BETTER WORK**

For more data circle 543 on Post Card

another outstanding design development from

*Aerovent*




**direct-connected**

# vaneaxial fans

**with removable vane sections**

Engineered for high-pressure, high-velocity air distribution systems, these units feature a unique removable vane section which simplifies installation and permits easy access for routine cleaning and maintenance.

Available in 30 models in sizes 18" to 48" for capacities from 3230 to 67,300 cfm with special design features for all application requirements.

Write for Bulletin 475

Air deliveries of all Aerovent equipment are tested and rated in accordance with established and accepted codes and each unit is guaranteed by the manufacturer to deliver its rated performance.

CERTIFIED PERFORMANCE

Aerovent

*Aerovent*

**FAN COMPANY, INC.**

ASH AND BRUSH STREETS PIQUA, OHIO

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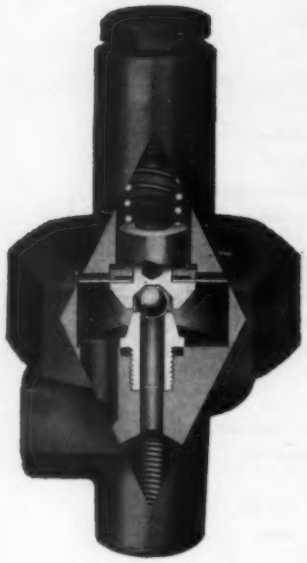

## THIS PREMIUM RELIEF VALVE PROVIDES ABSOLUTE SAFETY IN CORROSIVE SERVICE

- The Milton Roy full-lift design assures immediate and positive relief when the set pressure is reached, yet there's no chattering or leakage as the relief valve approaches its set pressure.
- Continued leak-free operation is assured even after the valve has opened in corrosive service, because topworks are completely isolated from the process stream by a Teflon diaphragm.
- Wetted parts are available in steel, 316 stainless, Carpenter 20 stainless, Hastelloy "C" or "B", or PVC. Sizes range from ¼" up for pressures to 1500 psi. Back pressure valves are also available.

*For complete information, request Bulletin 357-2 from Milton Roy Co., 1300 East Mermaid Lane, Philadelphia 18, Pennsylvania.*

milton Roy

CHEMICAL INSTRUMENTATION SYSTEMS

Controlled Volume Pumps • Quantichem Analyzers
Chemical Feed Systems • pH Instruments

For more data circle 545 on Post Card

# How is it possible for Island Creek coal to lower the cost per 1000 pounds of steam? . . .

## It's Precisioneered*

Regular and frequent quality control tests are made on coal samples from all Island Creek mines. Here a technician is testing for BTU content.

* PRECISIONEERING is a chain of controlled events that actually begins and ends at your burning equipment. It starts with the question: What kind of coal does your equipment require to produce steam at the lowest net cost per 1000 lbs.? It provides the answer, through penetrating engineering and evaluation studies. It produces the answer . . . with superior seams of coal prepared exactly to your determined specifications in modern preparation plants, using precision engineering techniques and strictest laboratory controls. We'd welcome a chance to discuss the possible reduction of your net costs through Precisioneering. Write. Or phone. No obligation, of course.

**ISLAND CREEK**
**Precisioneered Coal**

*You can depend on Island Creek . . . a career company dedicated to coal*

Island Creek Coal Sales Company, Chafin Building, Huntington 18, West Virginia • Chicago • Cincinnati • Cleveland • Detroit • Greensboro • New York • Pittsburgh

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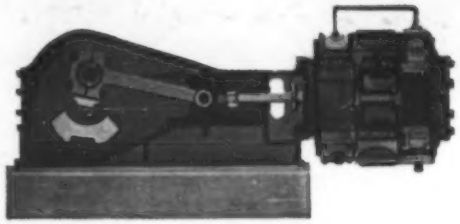


# HIDDEN VALUES?

## Are they all in Worthington Horizontal Compressors?

Frankly, they're not. And we're glad! One of the "hidden values" listed below we'd hate to sell—see if you can tell which one it is. (Correct answer on page 95.)

On the other hand, we're extremely happy to be selling horizontal compressors with the other 24 "hidden values" built in. (Not everyone does.)

Frankly, we could drop many of these and 99 users out of 100 might never know it. But the 100th could suffer untold expense . . . so we keep them all for everyone. To buy these "hidden values", please contact your local Worthington representative next time you specify a compressor. Worthington Corporation, Compressor and Engine Division, Buffalo, N. Y. 36-10

**SALES AND SERVICE INTEGRATION** recognizes kinship of one to the other. One man administers both.

**MAGNAFLUX AND MAGNAGLO** inspections are widely used to expose surface imperfections.

**ADJUSTABLE ROLLER MAIN BEARINGS** feature low friction losses which help to extend compressor life.

**INTEGRATED DIV.** includes foundry, manufacturing, sales, service and engineering in one location.

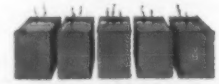
**FEATHER VALVE** — industry's preferred compressor valve—is efficient, quiet, and low in maintenance.

**CAPACITY CONTROL** —choice of simple bypass, through dual to complex sequential control systems.

**FLEXIBILITY** — oil or non-lube; single or multi-stage; Worthington MVD, direct or geared drive.

**ULTRASONIC TEST** — an advanced method of examining certain critical parts for internal quality.

**ACCESSIBILITY** — valves, packing and main parts are easily observed and reached by operators.



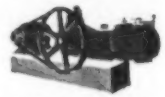
**PARCO-LUBRITING** of critical wearing surfaces completely eliminates most start-up scuffing problems.

**ONE-PIECE FRAME** includes built-in housing with full foundation support to minimize stresses.

**2000 CRAFTSMEN,** these units built by same men who design and build large 5000 hp, 15,000 psi units.

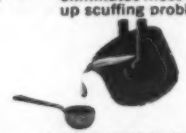
**KOLENE PROCESS** removes impurities from crankpin bearing shell that weaken bond to babbitt.

**OPTIC COMPARATOR** is used to check connecting rod bolt threads for uniform angles, lead and form.

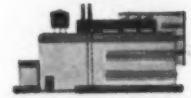


**FACTORY ASSEMBLY** and shop run-in on air insure proper operation and reduce installation costs.

**FINISHED GROUND BEARING SHELLS** provide crankpin positive full-contact backing for long life.



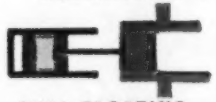
**COMPOSITION TEST** determines constituents of molten iron in each ladle before any casting is poured.



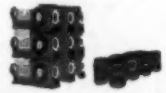
**$1,000,000 ADDITION TO LABORATORY** assures sound equipment designs based on actual research.

**COUNTERWEIGHTED CRANKSHAFT** eliminates vibration and insures a smoother operation.

**DISTRIBUTORS** — over 200 in major markets give local supply and close contact with Worthington offices.



**FULL-FLOATING WRISTPINS** in piston give minimum piston and cylinder wear and reduce maintenance.



**STOCKING PROGRAM** standard air and gas gathering units are kept in stock to give short shipments.

**PROFILOMETER** inspection of highly finished parts assures easy break-in and long life.

**THERMODYNAMICS SECTION** analyzes special application to size unit and determines performance.

**DESTRUCTION TEST** of complete compressor cylinders verifies engineers' design calculations.